INDEX

MERCURY
MerCruiser

# SERVICE MANUAL

Number 32

## 4.3L MPI GASOLINE ENGINE
## SN 0M322781 and ABOVE

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# Notice

Throughout this publication, Dangers, Warnings and Cautions (accompanied by the International HAZARD Symbol ⚠ ) are used to alert the mechanic to special instructions concerning a particular service or operation that may be hazardous if performed incorrectly or carelessly. **OBSERVE THEM CAREFULLY!**

These Safety Alerts alone cannot eliminate the hazards that they signal. Strict compliance to these special instructions when performing the service, plus Common Sense operation, are major accident prevention measures.

**⚠ DANGER**

**Immediate hazards which will result in severe personal injury or death.**

**⚠ WARNING**

**Hazards or unsafe practices which could result in severe personal injury or death.**

**⚠ CAUTION**

**Hazards or unsafe practices which could result in minor personal injury or product or property damage.**

# Notice to Users of This Manual

This service manual has been written and published by the Service Department of Mercury Marine to aid our dealers' mechanics and company service personnel when servicing the products described herein.

It is assumed that these personnel are familiar with marine product servicing procedures. Furthermore, it is assumed that they have been trained in the recommended service procedures of Mercury MerCruiser product, including the use of mechanics' common hand tools and the special Mercury Marine or recommended tools from other suppliers.

We could not possibly know of and advise the marine trade of all conceivable procedures and of the possible hazards and/or results of each method. Therefore, anyone who uses a service procedure and/or tool, which is not recommended by the manufacturer, first must completely satisfy himself that neither his nor the products safety will be endangered.

All information, illustrations and specifications contained in this manual are based on the latest product information available at the time of publication. As required, revisions to this manual will be sent to all dealers contracted by us to sell and/or service these products.

We reserve the right to make changes to this manual without prior notification.

Refer to dealer service bulletins, operation maintenance and warranty manuals and installation manuals for other pertinent information concerning the products described in this manual.

## Precautions

It should be kept in mind, while working on the product, that the electrical system and ignition system are capable of violent and damaging short circuits or severe electrical shocks. When performing any work where electrical terminals could possibly be grounded or touched by the mechanic, the battery cables should be disconnected at the battery.

Any time the intake or exhaust openings are exposed during service they should be covered to protect against accidental entrance of foreign material which could enter the cylinders and cause extensive internal damage when the engine is started.

It is important to note, during any maintenance procedure replacement fasteners must have the same measurements and strength as those removed. Numbers on the heads of the metric bolts and on the surfaces of metric nuts indicate their strength. American bolts use radial lines for this purpose, while most American nuts do not have strength markings. Mismatched or incorrect fasteners can result in damage or malfunction, or possibly personal injury. Therefore, fasteners removed should be saved for reuse in the same locations whenever possible. Where the fasteners are not satisfactory for re-use, care should be taken to select a replacement that matches the original.

# Engine Mechanical Components

Many of the engine mechanical components are designed for marine applications. Unlike automotive engines, marine engines are subjected to extended periods of heavy load and wide open throttle operation and, therefore, require heavy-duty components. Special marine engine parts have design and manufacturing specifications that are required to provide long life and dependable performance. Marine engine parts also must be able to resist the corrosive action of salt or brackish water that will rust or corrode standard automotive parts within a short period of time.

Failure to use recommended Quicksilver service replacement parts can result in poor engine performance and/or durability, rapid corrosion of parts subjected to salt water and possibly complete failure of the engine.

# Replacement Parts

Use of parts other than the recommended service replacement parts, will void the warranty on those parts that are damaged as a result.

**⚠ WARNING**

**Electrical, ignition and fuel system components on Mercury MerCruiser Engines and Stern Drives are designed and manufactured to comply with U.S. Coast Guard Rules and Regulations to minimize risks of fire or explosion.**

**Use of replacement electrical, ignition or fuel system components, which do not comply to these rules and regulations, could result in a fire or explosion hazard and should be avoided.**

**When servicing the electrical, ignition and fuel systems, it is extremely important that all components are properly installed and tightened. If not, any electrical or ignition component opening would permit sparks to ignite fuel vapors from fuel system leaks, if they existed.**

# Models Covered in This Manual

| Sterndrive (MCM) | Serial Number |
|---|---|
| 4.3L MPI Alpha and Bravo | 0M300000 and Above |

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# IMPORTANT INFORMATION

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1 A

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# Introduction

This comprehensive overhaul and repair manual is designed as a service guide for the models previously listed. It provides specific information, including procedures for disassembly, inspection, assembly and adjustment to enable dealers and service mechanics to repair and tune these engines.

Before attempting repairs or tune-up, it is suggested that the procedure first be read through to gain knowledge of the methods and tools used and the cautions and warnings required for safety.

# How To Use This Manual

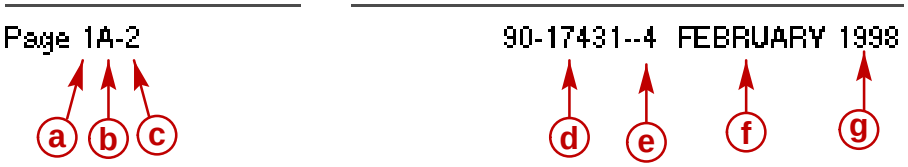
This manual is divided into sections which represent major components and systems.

Some sections are further divided into parts that more fully describe the component.

Refer to the Service Manual Outline following Models Covered In This Manual for section titles.

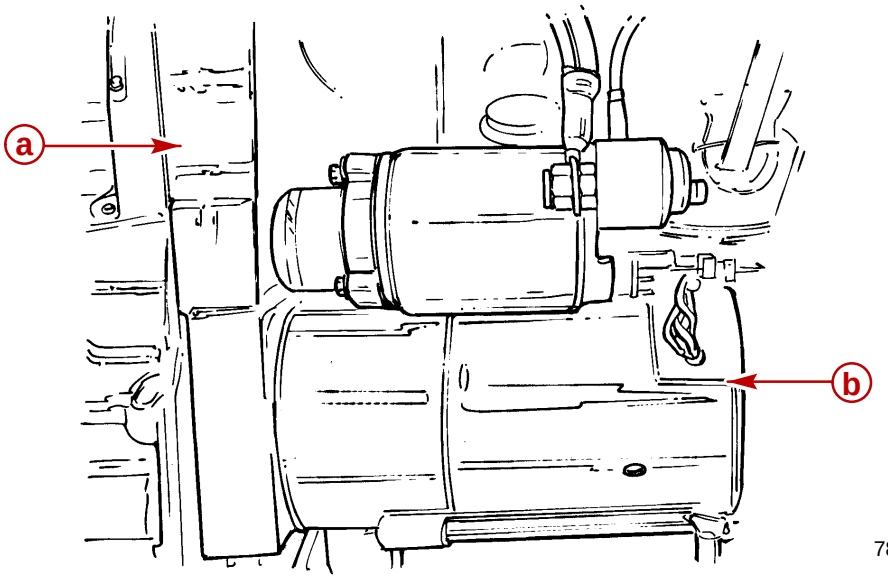
## Page Identification

The service manual number and section title appear at the top of the page. Two number groups appear at the bottom of each page. Following is an example and a description.



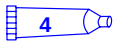
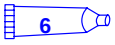
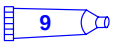
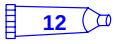
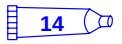
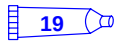
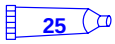
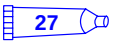
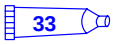
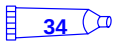
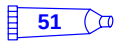
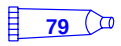
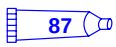
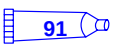
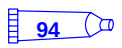
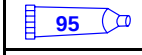
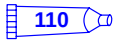
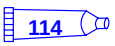

**a** - Section Number
**b** - Section Part
**c** - Page Number
**d** - Manual Number
**e** - Revision Number
**f** - Month Printed
**g** - Year Printed

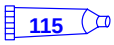
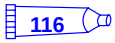
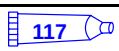
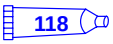
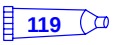
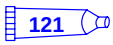
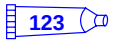
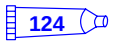
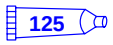
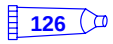
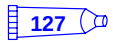
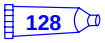
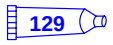
# Engine Serial Number Locations




**a** - Serial Number Plate
**b** - Starter Motor

# Mercury/Quicksilver Lubricants, Sealants And Adhesives

| Tube Ref. # | Description | Container Size | Mercury Part Number | Quicksilver Part Number |
|---|---|---|---|---|
|  | Needle Bearing Assy. Lubricant | 8 oz (226.8 g) tube | N/A | 92-802868A1 |
|  | Dielectric Grease | 8 oz (226.8 g) can | N/A | 92-823506-1 |
| | Loctite 271 - Thread Locker | 10 ml tube | N/A | 92-809819 |
|  | Loctite 567 PST Pipe Sealant | 50 ml tube | N/A | 92-809822 |
|  | Loctite Master Gasket Kit | | N/A | 92-12564-2 |
|  | 2 Cycle Premium Outboard Oil | 1 US qt (0.94 L) | 92-802813A1 | 92-802813Q1 |
|  | Perfect Seal | 16 oz (0.45 kg) can | N/A | 92-34227-1 |
|  | Liquid Neoprene | 8 oz (226.8 g) can | N/A | 92-25711-3 |
|  | Bellows Adhesive | 1.5 oz (42.5 g) tube | N/A | 92-86166Q1 |
|  | Loctite 680 Retaining Compound | 10 ml tube | N/A | 92-809833 |
|  | Special Lubricant 101 | 8 oz (226.8 g) tube | 92-802865A1 | 92-802865Q1 |
| | U-Joint and Gimbal Bearing Grease | | 92-802870A1 | 92-802870Q1 |
|  | Loctite 222 Thread Locker | 10 ml tube | N/A | 92-809818 |
| | Loctite 242 Thread Locker | 10 ml tube | N/A | 92-809821 |
|  | 4 Cycle 25W40 Engine Oil | | 92-802837A1 | 92-802837Q1 |
| | Premium Gear Lubricant | 1 US qt (0.94 L) | 92-802846A1 | 92-802846Q1 |
|  | High Performance Gear Lube | 1 US qt (0.94 L) | 92-802854A1 | 92-802854Q1 |
|  | Engine Coupler Spline Grease | 14 oz (0.39 kg) cartridge | 92-802869A1 | 92-802869Q1 |
|  | Anti-Corrosion Grease | 8 oz (226.8 g) tube | 92-802867A1 | 92-802867Q1 |
|  | 2-4-C with Teflon | 8 oz (226.8 g) tube | 92-802859A1 | 92-802859Q1 |
|  | 4 Stroke 10W30 Outbound Oil | 1 US qt (0.94 L) | 92-802833A1 | 92-802833Q1 |
|  | Power Trim & Steering Fluid | 8 oz (226.8 g) | 92-802880A1 | 92-802880Q1 |

| Tube Ref. # | Description | Container Size | Mercury Part Number | Quicksilver Part Number |
|---|---|---|---|---|
|  | Premium Plus 2 Cycle TC-W3 Outboard Oil | 1 US qt (0.94 L) | 92-802824A1 | 92-802824Q1 |
|  | RTV 587 Silicone Sealer | 3 oz (85.05 g) | N/A | 92-809825 |
|  | Loctite 7649 Primer N | 4.5 oz (127.57 g) | N/A | 92-809824 |
|  | Storage Seal Rust Inhibitor | 12 oz (325 ml) spray can | 92-802878-56 | 92-802878Q56 |
|  | Corrosion Guard | 12 oz (325 ml) spray can | 92-802878 55 | 92-802878Q55 |
| | 15W40 4-cycle Diesel Engine Oil | 1.06 US gal.(4 L) | 92-877695K1 | 92-877695Q1 |
|  | Extended Life Antifreeze/Coolant | 1 US gal. (3.78 L) | 92-877770K1 | 92-877770K1 |
| | Marine Engine Coolant | 1.33 US gal. (5 L) | N/A | 92-813054A2 |
|  | Fuel System Treatment and Stabilizer Concentrate | 16 oz (437 ml) | 92-802876A1 | 92-802876Q1 |
|  | Heat Transfer Compound | 1.5 oz (42.5 g) tube | N/A | 92-805701 1 |
|  | Liquid Gasket | | N/A | 92-808137 |
|  | T442 Sealant | | N/A | 92-862258 |
|  | Loctite 5900 Ultra Black RTV Silicone Sealant | 13 oz (371 g) tube | N/A | 92-809826 |
|  | Loctite Gasket Remover | 18 oz (532 ml) spray can | N/A | 92-809828 1 |
|  | Sealer Kit, Two Part Epoxy | | N/A | 92-65150 1 |
| | Dexron III Automatic Transmission Fluid | | Obtain Locally | Obtain Locally |
| | Loctite 592 | | Obtain Locally | Obtain Locally |
| | Loctite Quick Tite | | Obtain Locally | Obtain Locally |
| | Isopropyl Alcohol | | Obtain Locally | Obtain Locally |
| | Hot Glue | | Obtain Locally | Obtain Locally |
| | Loctite 609 | | Obtain Locally | Obtain Locally |
| | Loctite 405 | | Obtain Locally | Obtain Locally |
| | Cyanacrylate Adhesive | | Obtain Locally | Obtain Locally |
| | 3M Permabond #3M08155 | | Obtain Locally | Obtain Locally |
| | Loctite 262 | | Obtain Locally | Obtain Locally |

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# IMPORTANT INFORMATION

## Section 1B - Maintenance

1 B

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# Torque Specifications

***NOTE:*** *Securely tighten all fasteners not listed below.*

| Description | Nm | lb-in. | lb-ft |
|---|---|---|---|
| Steering Lever Clamping Bolt And Nut | 67.8 | | 50 |
| Propeller Nut Alpha One, Bravo One and Bravo Two[1] | 75 | | 55 |
| Front Propeller Nut Bravo Three | 136 | | 100 |
| Rear Propeller Nut Bravo Three | 81 | | 60 |
| Rear Engine Mounts | 51.5 | | 38 |
| Flame Arrestor Bracket Nuts | 12 | | 9 |

[1] Amount specified is MINIMUM.

# Special Tools

| Description | Part Number |
|---|---|
| Flushing Device | 91-44357Q2 |
| Dual Water Pickup Flush Gear Case Seal Kit | 91-881150Q1 |
| Low Water Pickups Flushing Attachment | 849996T1 |
| Quicksilver Reference Electrode And Test Meter | 91-76675T1 |

## Kent-Moore Special Tools

| Kent-Moore Tools<br>29784 Little Mack<br>Roseville, MI 48066<br>Phone: (313) 574-2332<br>(800) 345-2233 | |
|---|---|
| **Description** | **Part Number** |
| Kent Moore Belt Tension Gauge | BT-3373-F |

# Lubricants / Sealants / Adhesives

| Description | Where Used | Part Number |
|---|---|---|
| 2-4-C Marine Lubricant With Teflon | Hinge Pins | 92-802859Q1 |
| U-joint And Gimbal Bearing Grease | Sterndrive Unit U-joint Crosses And Bearings, Drive Shaft | 92-828052A2 |
| | Gimbal Bearings | |
| High Performance Gear Lube | Propeller Shaft | 92-802856Q1 |
| Engine Coupler Spline Grease | Engine Coupler Splines, U-joint Shaft Splines | 92-816391A4 |
| Dexron III Automatic Transmission Fluid | Power Steering System | Obtain Locally |
| Engine Oil | Pivot Points, Guide Contact Surface, Starter Motor, Detent Ball And Holes, Water Separating Fuel Filter Sealing Ring, Oil Filter Sealing Ring | Obtain Locally |
| 2-Cycle Premium Outboard Oil | Water Separating Fuel Filter Layup | 92-802813A1 |
| Quicksilver Power Trim And Steering Fluid | Power Trim Pump | 92-802880Q1 |
| Corrosion Guard Spray | Power Package | 92-802878 55 |
| Mercury Extended Life Coolant/Antifreeze | Closed Cooling System | 92-877770K1 |
| Mercury Fuel System Treatment and Stabilizer | Fuel System | 92-802875A1 |
| Mercury Fuel System Treatment and Stabilizer Concentrate | Fuel System | 92-802876A1 |
| Premium Plus 2-Cycle TC-W3 Outboard Oil | Fuel System | 92-802824A1 |

# Engine And Tune-Up Specifications

## MCM (Sterndrive) Models

| Models | 4.3 L MPI |
|---|---|
| Propshaft Horsepower | 220 [1] |
| Propshaft Kilowatts | 164 |
| Number of Cylinders | V6 |
| Displacement | 4.3 liter (262 cid) |
| Bore/Stroke mm (in.) | 101.60 x 88.39 (4.012 x 3.480) |
| Compression Ratio | 9.2:1 |
| Compression Pressure | Minimum 100 psi (670 kPa) [4] |
| Specified WOT rpm Range[2] | 4400-4800 |
| Idle rpm in NEUTRAL[2] | 600 rpm [3] |
| Oil Pressure @ 2000 rpm [5] | Minimum 124 kPa (18 psi) |
| Oil Pressure @ Idle [5] | Minimum 55 kPa (4 psi) |
| Fuel Pressure (1800 rpm) | 296 kPa (43 psi) |
| Thermostat | 71 degrees C (160 degrees F) |
| Firing Order | 1-6-5-4-3-2 |
| Electrical System | 12-Volt Negative (–) Ground |
| Alternator Rating - Hot Operating Amps | 65 Amps |
| Alternator Rating - Cold Operating Amps | 72 Amps |
| Minimum Recommended Battery Rating | 550 cca / 825 mca / 150 Ah |
| Spark Plug Type | AC Platinum (AC 41-932) |
| Spark Plug Gap | 0.060 in. |

[1] Power rated in accordance with NMMA (National Marine Manufacturers' Association) rating procedures.

[2] Measured using an accurate service tachometer, with the engine at normal operating temperature.

[3] Idle speed on EFI models is not adjustable.

[4] Minimum recorded compression in any one cylinder should not be less than 70 percent of the highest recorded cylinder.

[5] Oil pressure must be checked with the engine at normal operating temperature.

# Fluid Specifications

**IMPORTANT: It may be necessary to adjust oil levels depending on the installation angle and the cooling systems (the heat exchanger and the fluid lines).**

## Engines

***NOTE:*** *All capacities are approximate fluid measures*

| All Models | Capacity Liters (U.S. qts) | Fluid Type |
|---|---|---|
| Crankcase Oil (With Filter) [1] | 5.20 (5-1/2) | Quicksilver 4-Cycle 25W-40 Marine Engine Oil |
| Seawater Cooling System [2] | 20 (21) | Propylene Glycol and Purified Water |
| Closed Cooling System | 19 (20) | Mercury Extended Life Coolant/Antifreeze or Extended Life Ethylene Glycol 5/100 Antifreeze/Coolant mixed 50/50 with Purified Water |

[1] Always use the dipstick to determine the exact quantity of oil or fluid required.

[2] Seawater Cooling System capacity information is for winterization use only.

## Sterndrives

***NOTE:*** *All capacities are approximate fluid measures*

***NOTE:*** *Drive unit oil capacity is with the gear lube monitor.*

| Model | Capacity Liters (U.S. qts) | Fluid Type |
|---|---|---|
| Alpha One | 1.89 (2) | High Performance Gear Lube |
| Bravo One | 2.60 (2.75) | |
| Bravo Two | 3.08 (3.26) | |
| Bravo Three | 2.84 (3) | |

# Maintenance Schedules

***NOTE:*** *Only perform maintenance which applies to your particular power package.*

## Maintenance Intervals

Maintenance intervals and the corresponding tasks to be performed, as shown in this current schedule or as found in a previously printed schedule, are generally based on an average boating application and environment. However, individual operating habits and personal maintenance preferences can have an impact on the suggested intervals. In consideration of these factors, Mercury MerCruiser has adjusted some maintenance intervals and the corresponding tasks to be performed. In some cases, this may allow for more individual tasks in a single visit to the servicing dealer. Therefore, it is very important that the boat owner and the servicing dealer discuss the current Maintenance Schedule and develop appropriate maintenance intervals to coincide with the individual operating habits, the environment and the maintenance requirements.

**⚠ CAUTION**

**Always disconnect the battery cables from the battery before working around electrical systems components to prevent injury to yourself and damage to the electrical system should a wire be accidentally shorted.**

# Gas Sterndrive

| Routine Maintenance * | Each Day Start | Each Day End | Weekly | Every Two Months |
|---|---|---|---|---|
| Check the crankcase oil (interval can be extended based on experience). | ★ | | | |
| If operating in salt, brackish or polluted waters, flush the cooling system after each use. | | ★ | | |
| Check the drive unit oil level, the trim pump oil level and the power steering pump fluid level. | | | ★ | |
| Check the water inlets for debris or marine growth. Check the seawater strainer and clean. Check the coolant level. | | | ★ | |
| Inspect the drive unit anodes and replace if 50 percent eroded. | | | ★ | |
| Lubricate the propeller shaft and retorque the nut (if operating in only freshwater, this maintenance may be extended to every four months). | | | | ★ |
| Operating in Saltwater Only: treat the engine surface with corrosion guard. | | | | ★ |
| Check the battery connections and the fluid level. | | | | ★ |
| Ensure that the gauges and the wiring connections are secure. Clean the gauges.[1] | | | | ★ or 50 hours |

* Only perform maintenance which applies to your particular power package

[1] If operating in saltwater, interval is reduced to every 25 hours or 30 days whichever occurs first

# Gas Sterndrive (continued)

| Scheduled Maintenance * | Annually | Every 100 hours or Annually ◆ | Every 200 hours or 3 years ◆ | Every 300 hours or 3 years ◆ | Every 2 years | Every 5 years |
|---|---|---|---|---|---|---|
| Touch-up paint the power package and spray with corrosion guard. | ★ | | | | | |
| Change the crankcase oil and filter. | | ★ | | | | |
| Change the drive unit oil and retorque the connection of the gimbal ring to the steering shaft. | | ★ | | | | |
| Replace the fuel filters. | | ★ | | | | |
| Check the steering system and the remote control for loose, missing or damaged parts. Lubricate the cables and the linkages. | | ★ | | | | |
| Inspect the U-joints, the splines and the bellows. Check the clamps. Check the engine alignment. Lubricate the U-joint splines. | | | ★ | | | |
| Lubricate the gimbal bearing and the engine coupler. | | | ★[8] | | | |
| Check the continuity circuit for loose or damaged connections. Test the MerCathode® unit output on Bravo Models. | | | ★ | | | |
| Retorque the engine mounts. | | | | ★ | | |
| Check the spark plugs, the wires and the distributor cap. | | | | ★ | | |
| Clean the flame arrestor and the crankcase ventilation hoses. Replace the PCV valve. | | | | ★ | | |

* Only perform maintenance which applies to your particular power package

◆ Whichever occurs first

8 Lubricate the engine coupler every 50 hours if operated at idle for prolonged periods of time

# Gas Sterndrive (continued)

| Scheduled Maintenance * | Annually | Every 100 hours or Annually ◆ | Every 200 hours or 3 years ◆ | Every 300 hours or 3 years ◆ | Every 2 years | Every 5 years |
|---|---|---|---|---|---|---|
| Check the electrical system for loose, damaged or corroded fasteners. | | | | ★ | | |
| Inspect the condition and the tension of the belts. | | | | ★ | | |
| Check the cooling system and exhaust system hose clamps for tightness. Inspect both systems for damage or leaks. | | | | ★ | | |
| Disassemble and inspect the seawater pump and replace worn components. | | | | ★ | | |
| Clean the seawater section of the closed cooling system. Clean, inspect and test the pressure cap. | | | | ★ | | |
| Replace the coolant. | | | | | ♠ | ★ |

* Only perform maintenance which applies to your particular power package

◆ Whichever occurs first

♠ Interval will be reduced if not using extended life coolant

# Crankcase Oil

To help obtain optimum engine performance and to provide maximum protection, we strongly recommend the use of Quicksilver 4-Cycle 25W-40 Marine Engine Oil. This oil is a special blend of 25-weight and 40-weight oils for marine engines. If not available, a good grade, straight weight, detergent automotive oil of the correct viscosity, with an API classification of SH, CF/CF-2, may be used.

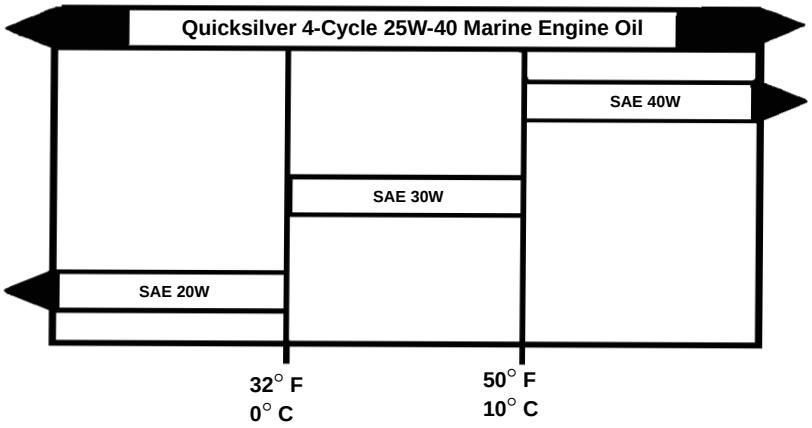
In those areas where Quicksilver 4-Cycle 25W-40 Marine Engine Oil or a recommended straight weight oil are not available, a multi-viscosity 20W-40 or, as a second but less preferable choice, 20W-50, with API service ratings of SH, CF/CF-2 may be used.

**IMPORTANT: The use of non-detergent oils, multi-viscosity oils (other than Quicksilver 25W-40 or a good quality 20W-40 or 20W-50), synthetic oils, low quality oils or oils that contain solid additives are specifically not recommended.**

The chart below is a guide to crankcase oil selection. The oil filter should always be changed when changing the engine oil.

**⚠ CAUTION**

**Mercury MerCruiser or Quicksilver 4-Cycle oil is recommended for use for your engine. Severe engine damage may result from the use of an inferior oil.**

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# Overfilled Crankcase Oil

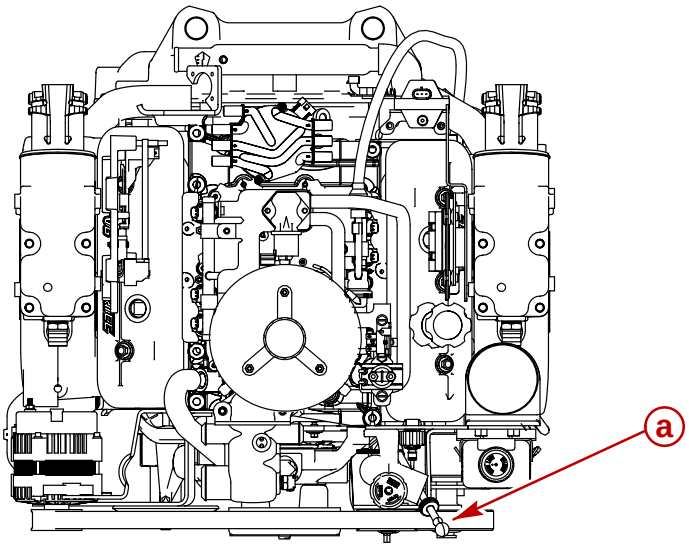
An overfilled crankcase (oil level being too high) can cause a fluctuation or drop in oil pressure and rocker arm clatter on Mercury MerCruiser engines. This condition results in the engine crankshaft splashing and agitating the oil, causing it to foam (become aerated). The aerated oil causes the hydraulic valve lifters to bleed down. This, in turn, results in rocker arm clatter and loss of engine performance, due to the valves not opening properly.

Care must be taken when checking the engine oil level. The oil level must be maintained between the ADD mark and the FULL or OK RANGE mark on the dipstick. To ensure that you are not getting a false reading, ensure the following:

- Boat at rest in the water, or
- If the boat is on a trailer, raise or lower the bow until the boat is setting at the approximate angle that it would be if setting at rest in the water.
- Allow sufficient time for the oil to drain into the crankcase if the engine has just been operated or oil has just been added.

## Checking

1. Stop the engine. Allow approximately five minutes for the oil to drain into the oil pan. The boat must be at rest in the water.

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**a** - Dipstick

2. Remove the dipstick. Wipe it clean and reinstall it fully into the dipstick tube.
3. Remove the dipstick and observe the oil level. The oil level must be between the FULL or OK RANGE and ADD marks. Fill as necessary with the specified fluid.

| All Models | Capacity Liters (U.S. qts) | Fluid Type |
|---|---|---|
| Crankcase Oil (With Filter) [1] | 5.20 (5-1/2) | 4-Cycle 25W-40 Marine Engine Oil |

[1] Always use dipstick to determine exact quantity of oil or fluid required.

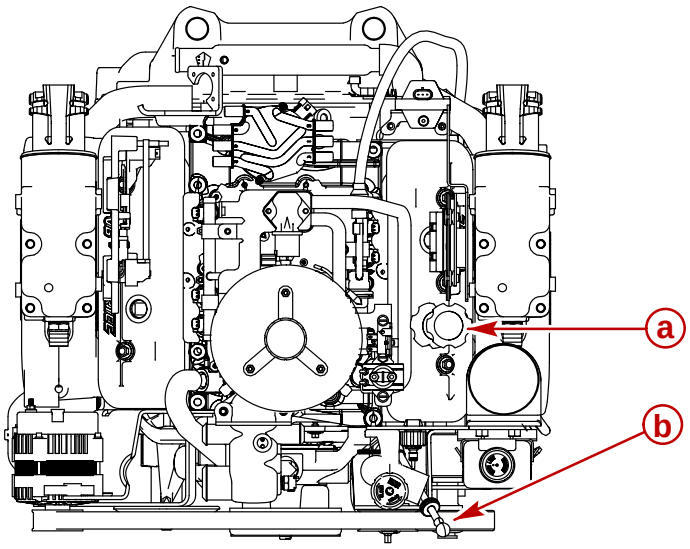
# Filling

**⚠ CAUTION**

**ENVIRONMENTAL HAZARD! Discharge of oil or oil waste into the environment is restricted by law. Do not spill oil or oil waste into the environment when using or servicing your boat. Contain and dispose of oil or oil waste as defined by local authorities.**

**IMPORTANT: Do NOT overfill the crankcase with oil.**

1. Remove the oil fill cap.

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**b** - Oil Fill Cap
**c** - Dipstick

2. Add the specified oil to bring the level up to, but not over the FULL or OK RANGE mark on the dipstick.

| All Models | Capacity Liters (U.S. qts) | Fluid Type |
|---|---|---|
| Crankcase Oil (With Filter) [1] | 5.20 (5-1/2) | 4-Cycle 25W-40 Marine Engine Oil |

[1] Always use the dipstick to determine the exact quantity of oil or fluid required.

# Changing Oil and Filter

Refer to the Maintenance schedule for the change interval. The crankcase oil should be changed before placing the boat in storage.

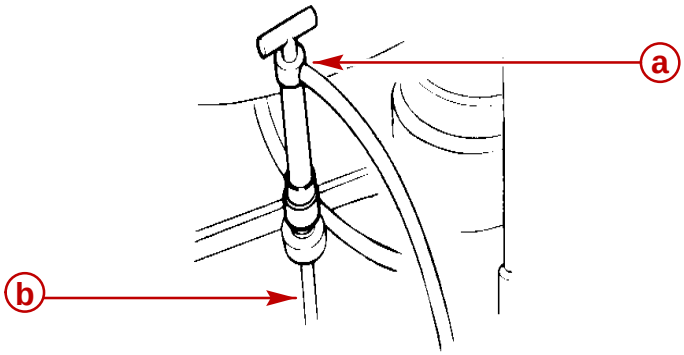
**IMPORTANT: Change the crankcase oil when the engine is warm from operation. Warm oil flows more freely, carrying away more impurities. Use only the recommended engine oil (refer to Specifications).**

## QUICK DRAIN OIL

1. Pull the tether through the bilge drain.
2. Place the oil drain hose in a suitable container.
3. Remove the drain plug from the oil drain hose.
4. After the oil has drained completely, install the drain plug in the oil drain hose.
5. Push the hose through the bilge drain and install the plug.
6. Proceed to ALL MODELS.

## CRANKCASE OIL PUMP

1. Remove the dipstick.
2. Insert the hose end of the crankcase oil pump onto an appropriate container and using the handle, pump until the crankcase is empty.

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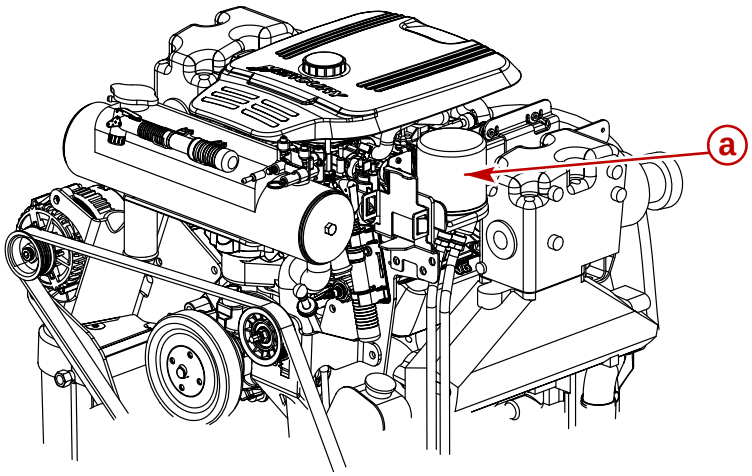
**a** - Crankcase Oil Pump
**b** - Dipstick

3. Remove the pump.
4. Install the dipstick.
5. Proceed to ALL MODELS.

## ALL MODELS

1. Remove and discard the oil filter.

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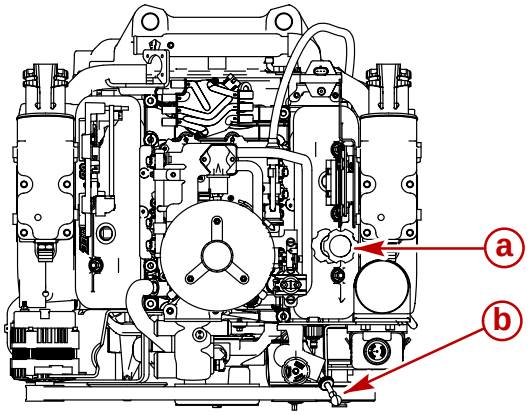
**a** - Oil Filter

2. Coat the sealing ring on the new filter with engine oil and install.
3. Tighten the filter securely (following filter manufacturer's instructions). Do NOT overtighten.
4. Remove the oil fill cap.

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**b** - Oil Fill Cap
**c** - Dipstick

5. Add the recommended engine oil to bring the level up to, but not over, the FULL or OK RANGE mark on the dipstick.

| All Models | Capacity Liters (U.S. qts) | Fluid Type |
|---|---|---|
| Crankcase Oil (With Filter) [1] | 5.20 (5-1/2) | 4-Cycle 25W-40 Marine Engine Oil |

[1] Always use dipstick to determine exact quantity of oil or fluid required.

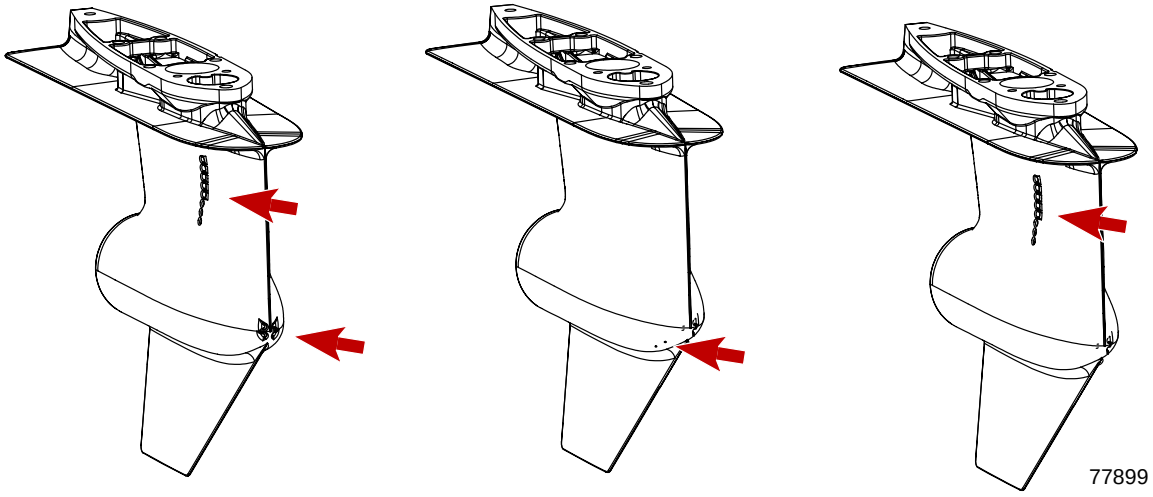
6. Start the engine and check for leaks.

# Flushing The Power Package - MCM

Your boat could come equipped with one of three different types of water pickups: through the hull, through the transom and through the sterndrive. The flushing procedures for these systems are separated into two categories: sterndrive water pickups and alternative water pickups.

## Sterndrive Water Pickups

There are three types of water pickups available on Mercury MerCruiser sterndrives: low water, dual water and side pickups. Dual water pickups require the flushing attachment (44357Q2) and the flush seal kit, low water pickups require the flushing attachment and side pickups require the flushing attachment.




**Dual Water Pickup** **Low Water Pickup** **Side Pickup**

| Description | Part Number |
|---|---|
| Flushing Device | 91-44357Q2 |
| Dual Water Pickup Flush Gear Case Seal Kit | 91-881150Q1 |
| Low Water Pickups Flushing Attachment | 849996T1 |

***NOTE:*** *Flushing is needed only for salty, brackish, mineral laden or polluted water applications. Flushing is recommended after each outing for best results.*

**⚠ CAUTION**

**If flushing with the boat in the water, seawater can flow into the engine causing engine damage. Water inlet must be closed when flushing the engine.**

1. Drain the seawater section of the cooling system.
2. If flushing cooling system with the boat in the water:
   a. Raise the sterndrive unit to the TRAILER position.
   b. Install the appropriate flushing attachment over the water intake openings in the gear housing.
   c. Lower the sterndrive unit to the full DOWN/IN position.

3. If flushing the cooling system with the boat out of the water:
   a. Lower the sterndrive unit to the full DOWN/IN position.

**⚠ WARNING**

**Contact with moving drive components and the propeller can cause personal injury or death. To avoid possible injury, remove the propeller and ensure that no people or animals are in the area of the drive unit while flushing.**

   b. Remove the propeller.
   c. Install the appropriate flushing attachment over the water intake openings in the gear housing.
4. Connect a hose between the flushing attachment and a water source.
5. With the sterndrive unit in normal operating position, partially open the water source (about 1/2 maximum).
6. Place the sterndrive in the NEUTRAL IDLE speed position and start the engine.

**⚠ CAUTION**

**Suction created by the seawater pickup pump may collapse the flushing water hose causing the engine to overheat. Avoid engine damage from overheating; do NOT operate the engine above 1500 rpm.**

7. Slowly advance the throttle until the engine reaches 1300 rpm (+/–100 rpm).

**⚠ CAUTION**

**Engine overheating can cause engine damage. To avoid, observe the water temperature gauge and ensure that the engine is operating in the normal range.**

8. Observe the water temperature gauge to ensure that the engine is operating in the normal range.
9. Operate the engine with the sterndrive in NEUTRAL for about 10 minutes or until the discharge water is clear.
10. Slowly return the throttle to the idle speed position.
11. Stop the engine.
12. Shut off the water and remove the flushing attachment.

# Alternative Water Pickups

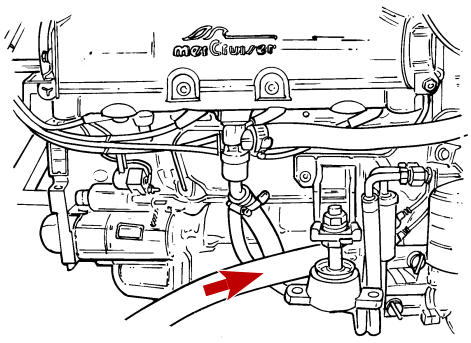
***NOTE:*** *Flushing is needed only for salty, brackish, mineral laden or polluted water applications. Flushing is recommended after each outing for best results.*

1. Drain the seawater section of the cooling system.
2. If flushing the cooling system with the boat in the water:
   a. Raise the sterndrive unit to the TRAILER position.
   b. Install the appropriate flushing attachment over the water intake openings in the gear housing.
   c. Lower the sterndrive unit to the full DOWN/IN position.
3. If flushing the cooling system with the boat out of the water:
   a. Lower the sterndrive unit to the full DOWN/IN position.

**⚠ WARNING**

**Contact with moving drive components and the propeller can cause personal injury or death. To avoid possible injury , remove the propeller and ensure that no people or animals are in the area of the drive unit while flushing.**

   b. Remove the propeller.
   c. Install the appropriate flushing attachment over the water intake openings in the gear housing.
4. Connect a hose between the flushing attachment and a water source.
5. Disconnect the water inlet hose (upper hose) from the aft side of the seawater pump.



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6. Using a suitable adapter, connect the flushing hose from the water source to the water inlet of the seawater pump.

**⚠ CAUTION**

**Overheating from insufficient cooling water will cause engine and drive system damage. Ensure that there is sufficient water always available at water inlet holes during operation.**

7. With sterndrive unit in normal operating position, partially open the two water sources (about 1/2 maximum).
8. Place sterndrive in NEUTRAL, idle speed position and start engine.

**⚠ CAUTION**

**Suction created by the seawater pickup pump may collapse the flushing water hose causing the engine to overheat. Avoid engine damage from overheating; do NOT operate the engine above 1500 rpm.**

9. Slowly advance throttle until engine reaches 1300 rpm (+/–100 rpm).

**⚠ CAUTION**

**Engine overheating can cause engine damage. To avoid, observe the water temperature gauge and ensure that the engine is operating in the normal range.**

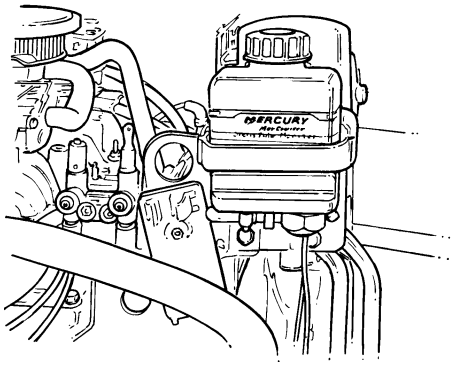
10. Observe the water temperature gauge to ensure that the engine is operating in the normal range.
11. Operate the engine with the sterndrive in NEUTRAL for about 10 minutes or until the discharge water is clear.
12. Slowly return the throttle to the idle speed position.
13. Stop the engine.
14. Shut off the water and remove the flushing attachments.
15. Install the water inlet hose to the aft side of the seawater pump.
16. Tighten the hose clamp securely.

# Sterndrive Unit Oil

## Checking

***NOTE:*** *Oil level will fluctuate during operation. The oil level should be checked with a cold engine before starting.*

1. Check the gear lube monitor oil level. Keep the oil level at or near the FULL line.

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2. If any water is visible at the bottom of the monitor or appears at the oil fill/drain plug and/or if the oil appears discolored, immediately determine the cause and correct. Refer to the appropriate Mercury MerCruiser Sterndrive Service Manual. Both conditions may indicate a water leak somewhere in the sterndrive unit.

## Filling

**IMPORTANT: If more than 59ml (2 fl. oz.) of fluid is required to fill the monitor, a seal may be leaking. Damage to the drive unit may occur due to lack of lubrication.**

**⚠ CAUTION**

**ENVIRONMENTAL HAZARD! Discharge of oil or oil waste into the environment is restricted by law. Do not spill oil or oil waste into the environment when using or servicing your boat. Contain and dispose of oil or oil waste as defined by local authorities.**

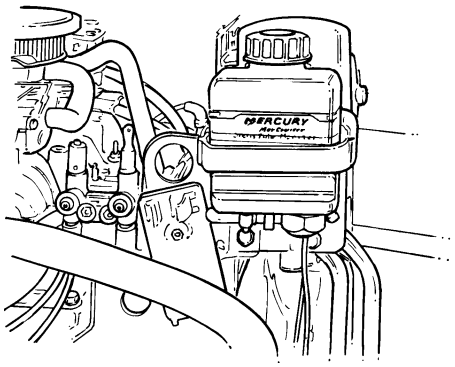
1. Remove the gear lube monitor cap.
2. Fill to the OPERATING RANGE line.

| Model | Capacity Liters (U.S. qts) | Fluid Type |
|---|---|---|
| Alpha One | 1.89 (2) | High Performance Gear Lube |
| Bravo One | 2.60 (2.75) | |
| Bravo Two | 3.08 (3.26) | |
| Bravo Three | 2.84 (3) | |

3. Replace the cap.

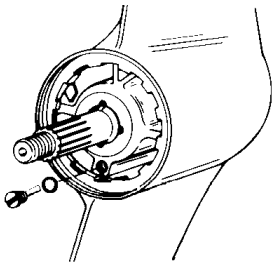
## Changing

1. Remove the gear lube monitor from the bracket.



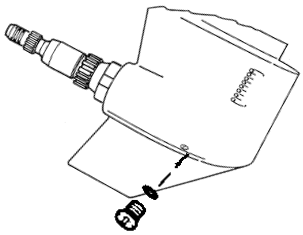

77813

2. Empty into a suitable container.
3. Install the monitor in the bracket.
4. **Bravo One Models:**
   a. Remove the propeller.
   b. Place the sterndrive unit in the full trim limit IN position.
   c. Remove the oil fill/drain screw and the sealing washer; drain the oil.



70568

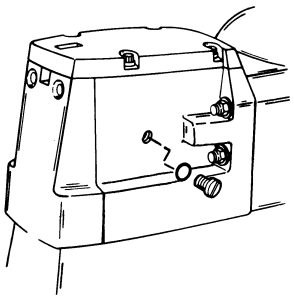
5. **All Other Models:**
   a. Place the sterndrive unit in the full trim limit OUT position.
   b. Remove the oil fill/drain screw and the sealing washer, drain the oil.



72522

**IMPORTANT: If any water drained from the oil fill/drain hole, or if the oil appears milky, the sterndrive unit is leaking and should be checked immediately.**

6. Remove the oil vent screw and the sealing washer. Allow the oil to drain completely.



77106

7. Lower the sterndrive unit until the propeller shaft is level.

**IMPORTANT: Use only specified fluid in the drive unit.**

8. Fill the drive unit, through the oil fill/drain hole, with the specified gear lube until an air-free stream of lubricant flows from the oil vent hole.
9. Install the oil vent screw and the sealing washer.
10. Continue to pump the gear lube into the gear lube monitor circuit until the gear lube appears in the gear lube monitor. Fill the monitor to the OPERATING RANGE line.
11. Ensure that the rubber gasket is inside the cap and install the cap. Do NOT overtighten.
12. Remove the pump from the oil fill/drain hole. Quickly install the sealing washer and the oil fill/drain screw. Tighten securely.
13. Bravo One and Alpha Models: Grease the propeller shaft heavily, with the specified lubricant. Reinstall the propeller and torque the nut.
14. Bravo Two Models: Grease the propeller shaft heavily, with the specified lubricant. Reinstall the propeller and torque the nut.
15. Bravo Three Models: Grease the propeller shaft heavily, with the specified lubricant. Reinstall the propeller and torque the nut.

| Description | Nm | lb-in. | lb-ft |
|---|---|---|---|
| Propeller Nut Alpha One, Bravo One and Bravo Two[1] | 75 | | 55 |
| Front Propeller Nut Bravo Three | 136 | | 100 |
| Rear Propeller Nut Bravo Three | 81 | | 60 |

[1] Amount specified is MINIMUM.

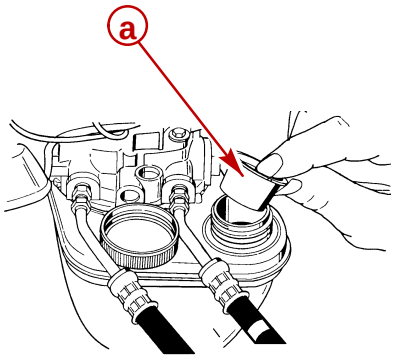
16. Recheck the oil level after first use.

**IMPORTANT: The oil level in the gear lube monitor will rise and fall during drive operation; always check the oil level when the drive is cool and the engine is off.**

# Power Trim Pump Fluid

## Checking

1. Place the sterndrive unit in the full DOWN/IN position.




70979

**a -** Cap Plug

2. Remove the fill cap from the reservoir and observe the oil level. The level must be up to, but not over the bottom of the filler neck.
   a. Ensure that the cap plug has been removed from the filler neck and discarded.

***NOTE:*** *The fill cap is vented.*

3. Fill as necessary with specified fluid.

## Filling

1. Remove the fill cap from the reservoir.
2. Add fluid to bring the level to the bottom of the filler neck.

| Description | Where Used | Part Number |
|---|---|---|
| Quicksilver Power Trim and Steering Fluid or SAE 10W-30 Engine Oil | Power Trim Pump | 92-802880Q1 |

3. Replace the cap.

## Changing

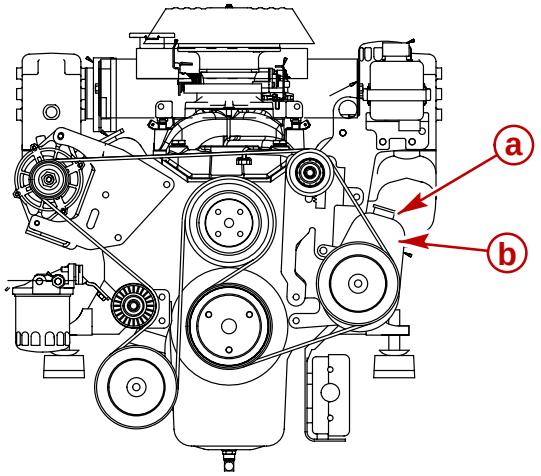
Power Trim fluid does not require changing.

# Power Steering Pump Fluid

## Checking

### ENGINE WARM

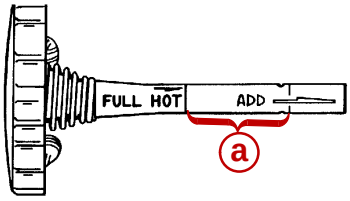
1. Stop the engine. Center the sterndrive unit.
2. Remove the fill cap / dipstick from the power steering pump and note the fluid level.




77108

**a** - Fill Cap / Dipstick
**b** - Power Steering Pump

3. The level should be between the FULL HOT mark and the ADD mark on the dipstick.




72518

**a** - Proper Fluid Level With Engine Warm

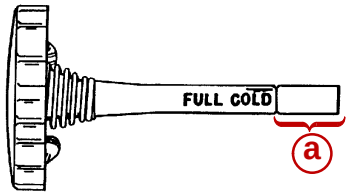
4. If the level is below the ADD mark, but fluid is still visible in the pump reservoir, add the required amount of fluid through the fill cap opening to bring the level up to the FULL HOT mark on the dipstick. Do NOT overfill.

| Description | Where Used | Part Number |
|---|---|---|
| Power Trim and Steering Fluid or Dexron III Automatic Transmission Fluid | Power Steering System | 92-802880Q1 |

5. If fluid is not visible in the reservoir, a leak exists in the power steering system. Find the cause and correct.

### ENGINE COLD

1. With the engine stopped, center the sterndrive unit.
2. Remove the fill cap / dipstick from the power steering pump and note the fluid level.
3. The level should be between the FULL COLD mark and the bottom of the dipstick.




72519

**a -** Proper Fluid Level With Engine Cold

4. If the level is below the bottom of the dipstick, but fluid is still visible in the pump reservoir, add the required amount of specified fluid through the fill cap opening to bring the level up to the FULL COLD mark on the dipstick. Do NOT overfill.

If fluid is not visible in the reservoir, a leak exists in the power steering system. Find the cause and correct.

## Filling and Bleeding

**IMPORTANT: The power steering system must be filled exactly as explained to ensure that all air is bled from the system. All air must be removed or fluid in the pump may foam during operation and be discharged from the pump reservoir. Foamy fluid also may cause the power steering system to become spongy, which may result in poor boat control.**

1. With the engine stopped, center the sterndrive unit.
2. Remove the fill cap / dipstick from the power steering pump.

**IMPORTANT: Use only specified fluid in the power steering system.**

3. Add specified fluid, as required, to bring the level up to the FULL COLD mark on the dipstick.
4. Turn the steering wheel back and forth to the end of travel in each direction several times.
5. Recheck the fluid level and add fluid, if necessary.

6. Install the vented fill cap. Tighten securely.

**⚠ CAUTION**

**DO NOT operate engine without water being supplied to seawater pickup pump or pump impeller may be damaged and subsequent overheating damage to engine may result.**

7. Start the engine and operate at fast idle (1300 rpm) until the engine reaches normal operating temperature. During this time, turn the steering wheel back and forth to the end of travel in each direction several times.
8. Center the sterndrive unit and stop the engine.
9. Remove the fill cap from the pump.
10. Allow any foam in the pump reservoir to disperse.
11. Check the fluid level and add fluid, as required, to bring the level up to the FULL HOT mark on the dipstick. Do NOT overfill**.**
12. Reinstall the fill cap. Tighten securely.

**IMPORTANT: The drive unit must be positioned straight back and the power steering fluid must be hot to accurately check the fluid level.**

13. If the fluid is still foamy (in Step 10.), repeat Steps 7. through 12. until the fluid does not foam and the level remains constant.

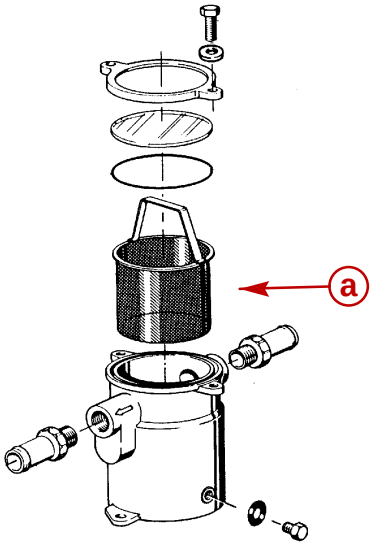
# Water Inlets

All water inlets should be inspected for obstruction. Refer to the maintenance charts for the interval.

1. Remove debris or marine growth from all water inlets.
2. Flush with clean water.

## Seawater Strainer

1. Remove the seawater strainer.
2. Disassemble the components.
3. Clean the filter element.




72673

**a** - Filter Element

4. Flush with clean water.
5. Reassemble the components.
6. Install the seawater strainer.

# Closed Cooling System

## Checking Coolant Level

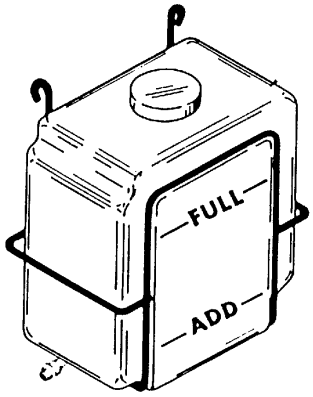
**⚠ CAUTION**

**Allow the engine to cool down before removing the pressure cap. A sudden loss of pressure could cause hot coolant to boil and discharge violently. After the engine has cooled, turn the cap 1/4 turn to allow any pressure to escape slowly, then push down and turn the cap all the way off.**

1. Remove the cap from the heat exchanger and observe the fluid level.
2. The coolant level in the heat exchanger should be at the bottom of the filler neck.

**IMPORTANT: When reinstalling the pressure cap, be sure to tighten it until it seats on the filler neck.**

3. With the engine at normal operating temperature, check the coolant level in the coolant recovery bottle.
4. The coolant level should be between the ADD and FULL marks.




72520

5. Add the specified fluid as necessary.

## Cleaning and Inspection

***NOTE:*** *Refer to SECTION 6C.*

1. Ensure that all hose clamps are tight and connections are secure.
2. Inspect the entire system for damage or leaks.
3. Clean the seawater section.
4. Clean, inspect and test the pressure cap.

## Changing Coolant

The coolant should be changed periodically based on the use of the specified coolant; refer to the maintenance charts for the interval. For the changing coolant procedures, refer to SECTION 6C.

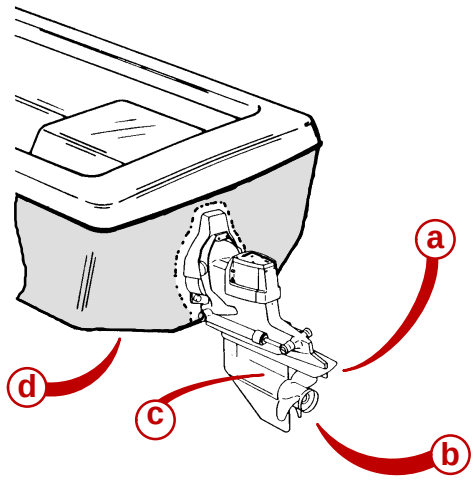
# Anodes

***NOTE:*** *Refer to the appropriate Mercury MerCruiser Sterndrive Service Manual for propeller removal and installation.*

**IMPORTANT: Replace the sacrificial anodes if eroded 50 percent or more.**

Each sterndrive unit is equipped with a sacrificial anodic plate to help protect underwater metal parts from galvanic corrosion. Because of its self-sacrificing nature, the anodic plate MUST BE replaced if eroded 50 percent or more.

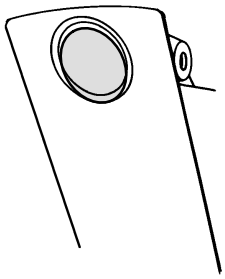
The sterndrive unit anodes should be inspected for erosion. Refer to the Maintenance Schedules for the interval.




71176

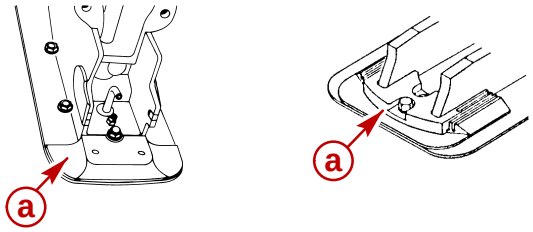
**a -** Universal Anodic Plate
**b -** Anodic Plate
**c -** MerCathode (If Equipped)
**d -** Anode Kit (If Equipped)

1. **Universal Anodic Plate -** Serves as a sacrificial anode.



73919

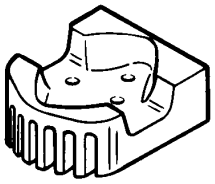
2. **Anodic Plate -** Serves as a sacrificial anode.




70575

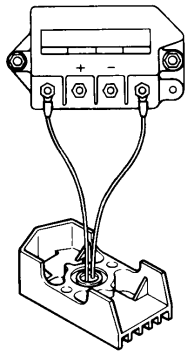
**a -** Anodic Plate

3. **Block (if equipped) -** Mounted to the underside of the gimbal housing and serves as a sacrificial anode.



70576

4. **MerCathode System (if equipped) -** Electrode assembly replaces the Anodic block.



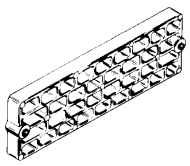

70578

The system should be tested to ensure adequate output.

The test should be made where the boat is moored, using Quicksilver Reference Electrode and Test Meter.

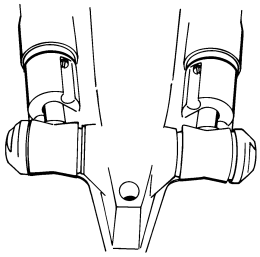
| Description | Part Number |
|---|---|
| Quicksilver Reference Electrode and Test Meter | 91-76675T1 |

5. **Anode Kit (if equipped) -** Mounted to the boat transom. Acts as a sacrificial anode.



70577

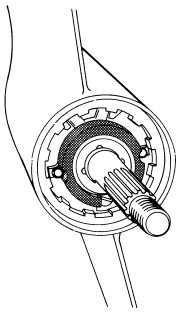
6. **Trim Cylinder Anodes -** Mounted on each trim cylinder. To replace the trim cylinder anodes:



71966

   a. Remove two screws from the anode.
   b. Clean the mounting surfaces down to the bare metal for proper contact.
   c. Install the new anode. Tighten the screws securely.

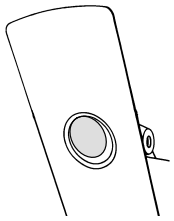
7. **Bearing Carrier Anode (Alpha and Bravo One) -** Located in front of the propeller, between the front side of the propeller and the gear housing. To replace the propeller anode:



72032

   a. Remove the propeller.
   b. Remove two screws from the anode.
   c. Clean the mounting surfaces down to the bare metal for proper contact.
   d. Install the new anode. Tighten the screws securely.
   e. Reinstall the propeller.

8. **Bearing Carrier Anode -** Located in front of the propeller, between the front side of the propeller and the gear housing.



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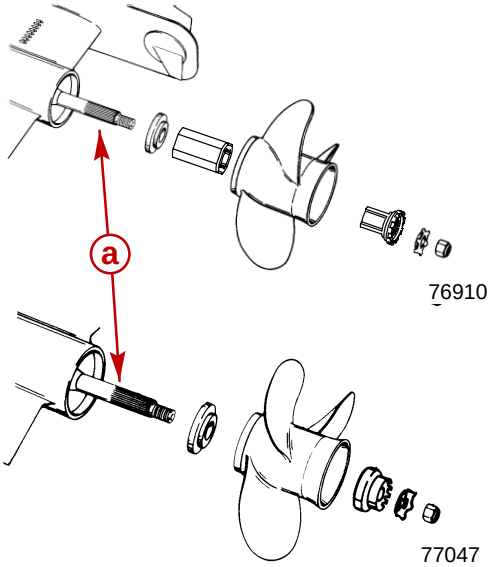
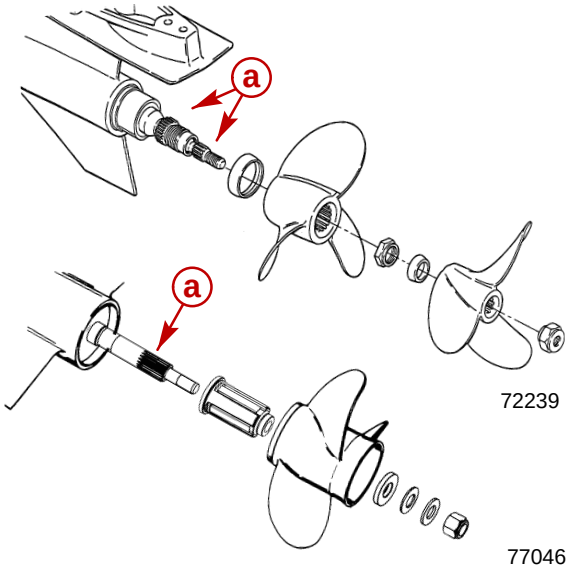
9. **Gear Housing Anode (Bravo Two and Three) -** Located in the splash plate, just above the propellers.

# Propeller Shaft

1. Lubricate the propeller shaft splines.




**Bravo One / Bravo Two Sterndrives**




**Bravo Three Sterndrives**

**a -** Propeller Shaft Splines

2. Retorque the propeller nut. Refer to the appropriate Mercury MerCruiser Sterndrive Service Manual or Operation, Maintenance and Warranty Manual for propeller removal and installation.

| Description | Nm | lb-in. | lb-ft |
|---|---|---|---|
| Propeller Nut Alpha One, Bravo One and Bravo Two[1] | 75 | | 55 |
| Front Propeller Nut Bravo Three | 136 | | 100 |
| Rear Propeller Nut Bravo Three | 81 | | 60 |

# Power Package Surfaces

The entire power package should be sprayed at recommended intervals with Corrosion Guard. Follow the instructions on the can for proper application.

***NOTE:*** *If operating in saltwater, the interval for treating the engine surface with Corrosion Guard will be reduced. Refer to Maintenance Schedules.*

| Description | Where Used | Part Number |
|---|---|---|
| Corrosion Guard Spray | Power package | 92-802878 55 |

The entire power package should be cleaned and the external surfaces that have become bare should be repainted with Primer and Spray Paint at recommended intervals. Refer to Maintenance Schedules.

## Painting Your Power Package

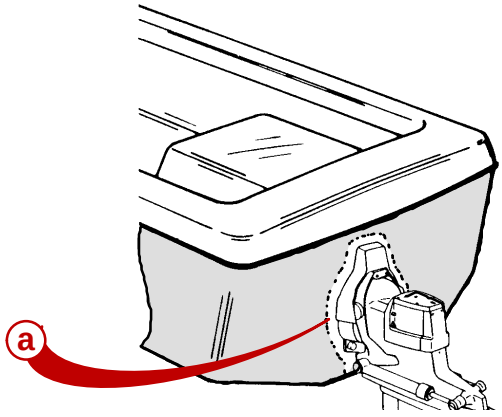
**IMPORTANT: Corrosion damage that results from the improper application of anti-fouling paint will not be covered by the limited warranty.**

1. **Painting the boat hull or the boat transom:** Anti-fouling paint may be applied to the boat hull and the boat transom but you must observe the following precautions:

**IMPORTANT: Do NOT paint the anodes or the MerCathode System reference electrode and anode, as this will render them ineffective as galvanic corrosion inhibitors.**

**IMPORTANT: If anti-fouling protection is required for the boat hull or the boat transom, copper or tin base paints, if not prohibited by law, can be used. If using copper or tin based anti-fouling paints, observe the following:**

- **Avoid any electrical interconnection between the Mercury MerCruiser Product, Anodic Blocks or MerCathode System and the paint by allowing a minimum of 40 mm (1-1/2 in.) UNPAINTED area on the transom of the boat around these items.**




71176

**a -** Minimum Unpainted Area

2. **Painting Drive Unit or Transom Assembly:** The drive unit and the transom assembly should be painted with a good quality marine paint or an anti-fouling paint that DOES NOT contain copper, tin or any other material that could conduct an electrical current. Do not paint the drain holes, the anodes, the MerCathode system, and items specified by the boat manufacturer.

# Battery

***NOTE:*** *Refer to the manufacturer's instructions.*

1. Ensure that the battery connections are secure.
2. Check the fluid level.

# Instruments

1. Ensure that the gauges are tight. Tighten the mounting bracket nuts, if loose. Do NOT overtighten.
2. Ensure that all gauge and wiring connections are tight and insulated where necessary.

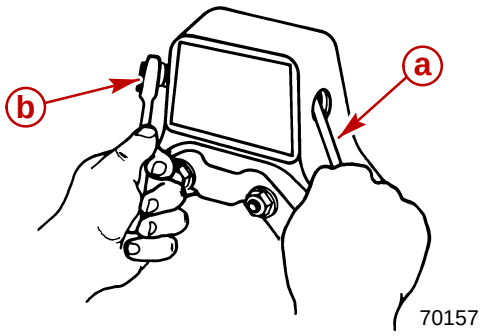
**IMPORTANT: The gauge may be scored or damaged if wiped with abrasive material such as sand, saline or detergent compounds or washed with solvents such as trichlorethylene and turpentine.**

3. Clean the gauges with fresh water to remove sand and salt deposits. Wipe with a soft cloth moistened with water.

# Gimbal Ring / Steering Connection

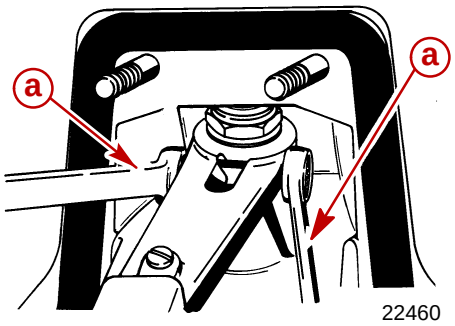
***NOTE:*** *Refer to the appropriate Mercury MerCruiser Sterndrive Service Manual for sterndrive removal and installation.*

1. Check the connection between the gimbal ring and the steering shaft.
2. Tighten the steering lever clamping bolt and nut.




**Engine and Transom Assembly**

**Installed**




**Removed**

**a** - Wrench
**b** - Socket Wrench

| Description | Nm | lb-in. | lb-ft |
|---|---|---|---|
| Steering Lever Clamping Bolt And Nut | 68 | | 50 |

# Changing Water Separating Fuel Filter

**⚠ WARNING**

**Avoid Fire or Explosion: The fuel injection system is pressurized during operation. Use care when removing the water separating fuel filter. Fuel could spray on the hot engine causing fire or explosion. Allow the engine to cool down before attempting to remove the water separating fuel filter in the following procedure. Also, hold a clean shop towel over the water separating fuel filter when removing it, to help avoid fuel spraying on the engine.**

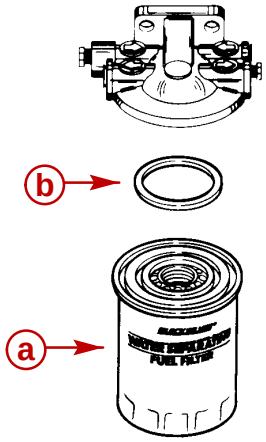
**⚠ WARNING**

**Be careful when changing the water separating fuel filter. Gasoline is extremely flammable and highly explosive under certain conditions. Ensure that the ignition key is OFF. Do not smoke or allow spark or open flame in the area when changing the fuel filter. Wipe up any spilled fuel immediately.**

**⚠ WARNING**

**Ensure that no fuel leaks exist before closing the engine hatch.**

1. Activate the Schrader valve located on the fuel rail to relieve pressure.
2. Remove the water separating fuel filter and the sealing ring from the mounting bracket and discard.




70573

**a** - Fuel Filter
**b** - Sealing Ring

3. Coat the sealing ring on the new filter with engine oil.

| Description | Where Used | Part Number |
|---|---|---|
| Engine Oil | Oil filter sealing ring | Obtain Locally |

4. Thread the filter onto the bracket and tighten securely by hand. Do not use a filter wrench.
5. Start and operate the engine.
6. Inspect the filter connection for gasoline leaks. If leaks exist, recheck the filter installation.

# Steering System

1. Inspect the steering system.
2. Ensure that there are no loose, missing or damaged components.
3. Repair or replace, as necessary.

# Remote Control

1. Inspect the remote controls.
2. Ensure that there are no loose, missing or damaged components.
3. Repair or replace, as necessary.

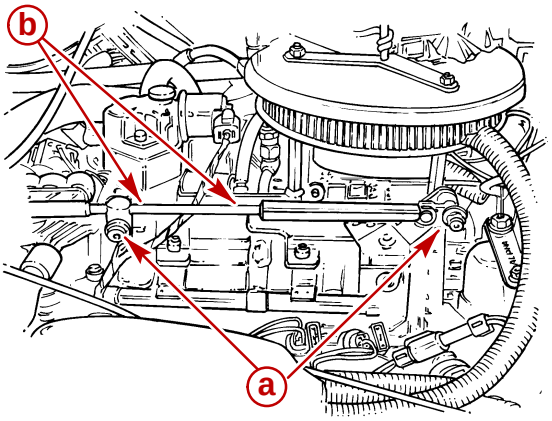
# Sterndrive Components

1. Inspect the U-joints.
2. Inspect the engine coupler splines.
3. Inspect the shaft splines.
4. Inspect the bellows.
5. Ensure that there are no loose, missing or damaged components.
6. Repair or replace, as necessary.

# Lubrication

## Throttle Cable

1. Lubricate the pivot points and the guide contact surfaces.




78033

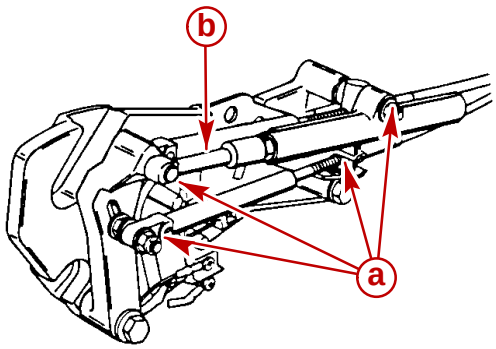
**a** - Pivot Points
**b** - Guide Contact Surfaces

| Description | Where Used | Part Number |
|---|---|---|
| Engine Oil | Pivot points, guide contact surfaces | Obtain Locally |

# Shift Cable

## ALL MODELS

1. Lubricate the pivot points and the guide contact surfaces.




71357

**Typical**

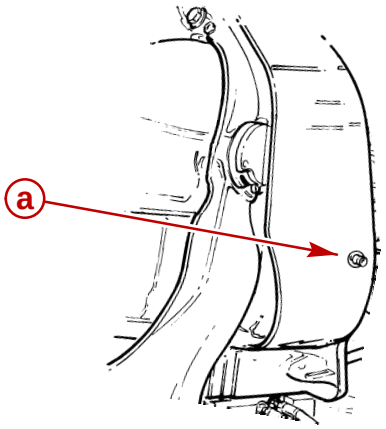
**a** - Pivot Points
**b** - Guide Contact Surfaces

| Description | Where Used | Part Number |
|---|---|---|
| Engine Oil | Pivot points, guide contact surfaces | Obtain Locally |

# Sterndrive Components

## GIMBAL BEARING

1. Lubricate the gimbal bearing by applying approximately 8-10 pumps of grease from a typical hand-operated grease gun.

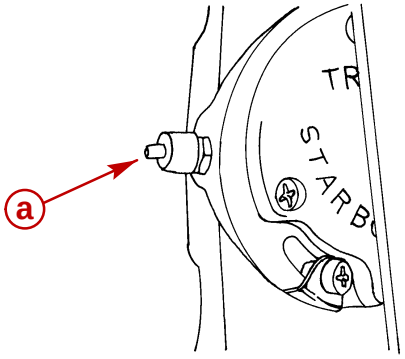



77068

**a** - Grease Fitting

| Description | Where Used | Part Number |
|---|---|---|
| U-joint And Gimbal Bearing Grease | Gimbal bearings | 92-828052A2 |

a. **Alpha Models -** Lubricate the hinge pins by applying a couple of pumps of grease from a typical hand-operated grease gun.




77044

**a -** Grease Fitting

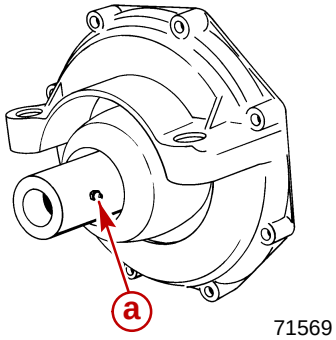
| Description | Where Used | Part Number |
|---|---|---|
| 2-4-C Marine Lubricant With Teflon | Hinge pins | 92-802859Q1 |

## ENGINE COUPLER AND SHAFT SPLINES

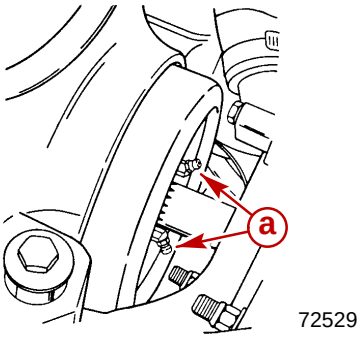
***NOTE:*** *Refer to the appropriate Mercury MerCruiser Sterndrive Service Manual for sterndrive unit removal and installation, if necessary.*

**IMPORTANT: These engines are equipped with a sealed engine coupler. The sealed coupler and the shaft splines can be lubricated without removing the sterndrive unit.**

1. Lubricate the engine coupler splines through the grease fittings on the coupler by applying approximately 8-10 pumps of grease from a typical hand-operated grease gun. If the boat is operated at idle for prolonged periods of time, the coupler should be lubricated **Bravo Models** - every 50 hours; **Alpha Models** - every 150 hours.




**Alpha Drive Coupler**




**Bravo Drive Coupler**

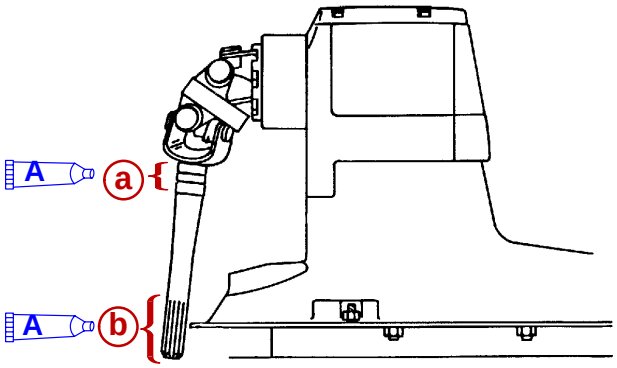
**a -** Grease Fitting

| Description | Where Used | Part Number |
|---|---|---|
| Engine Coupler Spline Grease | Engine coupler splines, U-joint shaft splines | 92-816391A4 |

## U-JOINTS

***NOTE:*** **All Models** - *These sterndrives are equipped with U-joints that do not require lubrication.*

1. Lubricate the U-joint shaft splines and the coupler splines.




72531

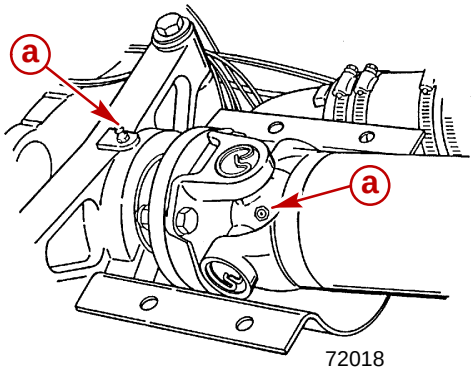
**Typical Bravo Drive**

**a -** U-joint Shaft Splines
**b -** Coupler Splines

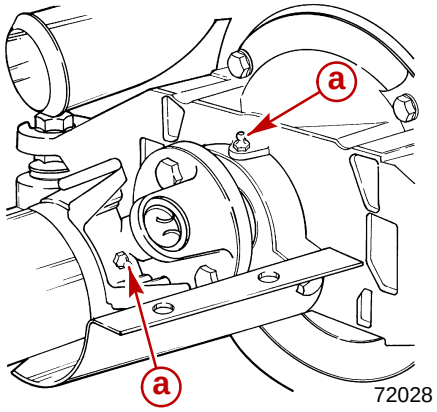
| Description | | Where Used | Part Number |
|---|---|---|---|
| A | Engine Coupler Spline Grease | Engine coupler splines, U-joint shaft splines | 92-816391A4 |

## DRIVE SHAFT EXTENSION MODELS

1. Lubricate the drive shaft grease fittings at the transom end by applying approximately 10-12 pumps of grease from a typical hand-operated grease gun.
2. Lubricate the drive shaft grease fittings at the engine end by applying approximately 3-4 pumps of grease from a typical hand-operated grease gun.




**Transom End**




**Engine End**

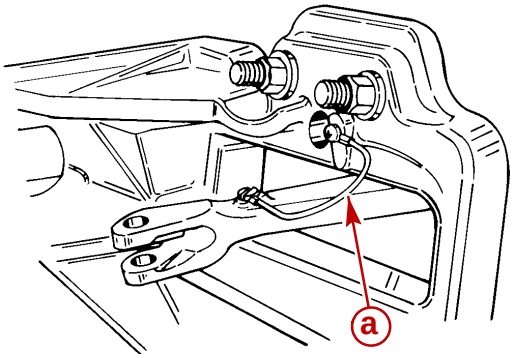
**a** - Grease Fitting

| Description | Where Used | Part Number |
|---|---|---|
| U-joint And Gimbal Bearing Grease | Sterndrive unit U-joint crosses and bearings, drive shaft | 92-828052A2 |

# Continuity Circuit

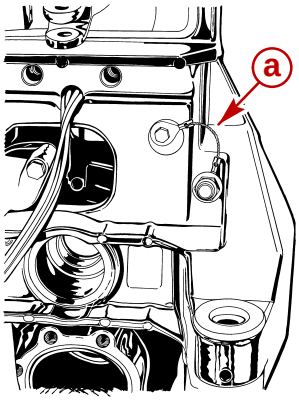
The transom assembly and the sterndrive unit are equipped with ground circuit wires to ensure good electrical continuity between the engine, the transom assembly and the sterndrive components. Good continuity is essential for the Anode and the MerCathode System to function most effectively.

1. Inspect the following ground circuit components for loose connections, broken or fraying wires.

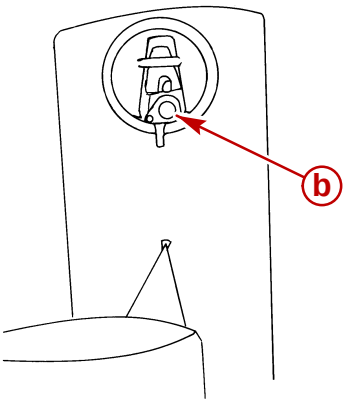



22028

**a** - Steering Lever Ground Wire

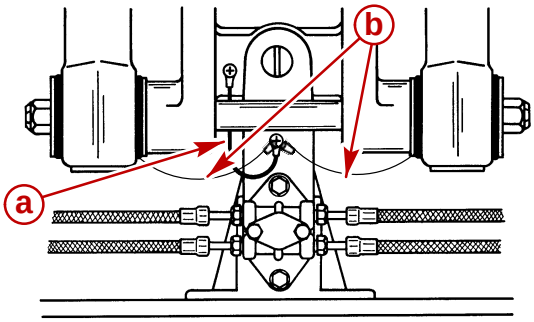



22650




77079

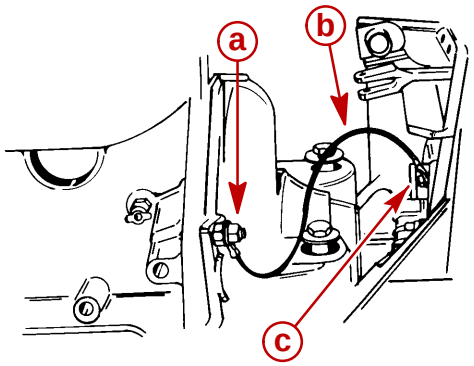
**a** - Inner Transom Plate To Gimbal Housing Ground Wire
**b** - Driveshaft Housing To Gear Housing Ground Plate (Inside Anode Cavity)




77100

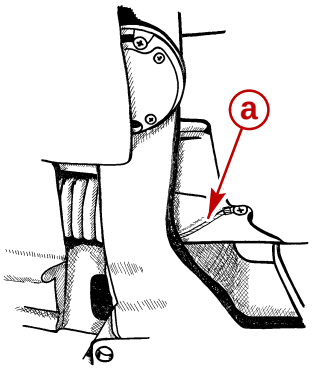
**a** - Gimbal Housing To Gimbal Ring Ground Wire
**b** - Gimbal Ring To Trim Cylinder Ground Wires

# Continuity Circuit (continued)

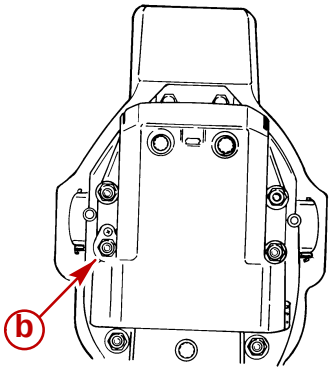



22028

**a** - Flywheel Housing Grounding Stud
**b** - Ground Wire
**c** - Inner Transom Plate Grounding Screw

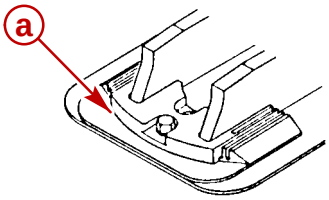



22755

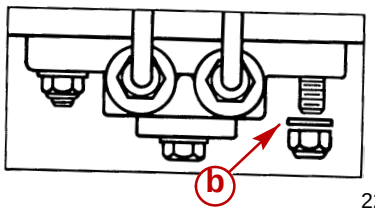



22031

**a** - Gimbal Ring To Bell Housing Ground Wire
**b** - Sterndrive Unit To Bell Housing Ground Plate

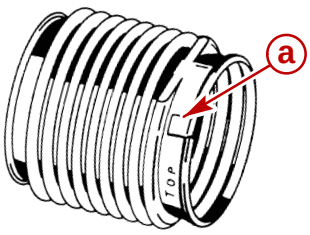



70575

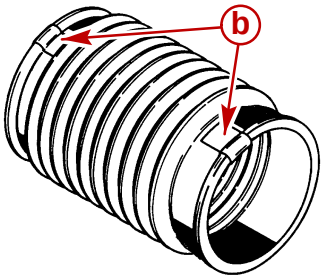



22230

**a** - Driveshaft Housing To Gear Housing Anodic Plate
**b** - Hydraulic Connector Block To Gimbal Housing Ground Washer




50383




22079

**a** - U-joint Bellows Ground Clip
**b** - Exhaust Bellows Ground Clips

# MerCathode

If the boat is equipped with a Quicksilver MerCathode System, the system should be tested to ensure that it is providing adequate output to protect the underwater metal parts on the boat. The test should be made where the boat is moored, using Quicksilver Reference Electrode and Test Meter.

| Description | Part Number |
|---|---|
| Quicksilver Reference Electrode and Test Meter | 91-76675T1 |

Refer to the appropriate Mercury MerCruiser Sterndrive Service Manual for testing procedures.

# Engine Mounts

1. Torque the rear engine mounts. Refer to SECTION 2.

| Description | Nm | lb-in. | lb-ft |
|---|---|---|---|
| Rear Engine Mounts | 51 | | 38 |

# Electrical System

***NOTE:*** *Refer to SECTION 4 for specific procedures.*

1. Inspect the spark plugs.
2. Inspect the spark plug wires.
3. Inspect the distributor cap.
4. Inspect the entire electrical system for loose, damaged or corroded fasteners.

# Cleaning Flame Arrestor

1. Remove the engine cover.
2. Remove the crankcase ventilation hose from the fitting on the side of the flame arrestor housing.
3. Remove the flame arrestor.
4. Clean the flame arrestor with water or steam. Dry with compressed air.
5. Clean the crankcase ventilation hoses. Dry with compressed air.
6. Inspect the crankcase ventilation hoses for cracks or deterioration and replace if necessary.
7. Install the flame arrestor and the crankcase ventilation hoses.
8. Install the flame arrestor bracket and tighten the nuts.

| Description | Nm | lb-in. | lb-ft |
|---|---|---|---|
| Flame Arrestor Bracket Nuts | 12 | | 9 |

9. Install the engine cover.

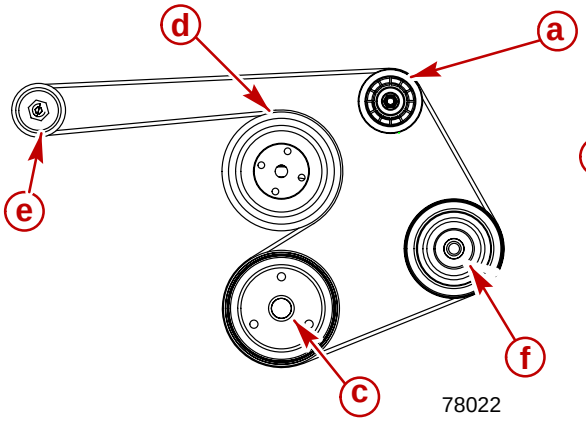
# Serpentine Drive Belt

**⚠ WARNING**

**Avoid possible serious injury. Ensure that the engine is shut off and the ignition key is removed before inspecting the belt.**

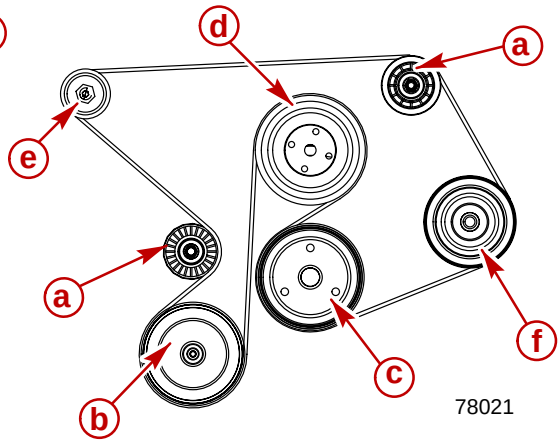
**IMPORTANT: The brackets and washers on the 3 idler pulleys must be in a certain order or the serpentine belt will come off. All pulleys are referenced as though you were standing in front of the engine looking at the belt.**

## Sterndrive Models



78022

**Without A Seawater Pump**



78021

**With A Seawater Pump**

- **a** - Idler Pulley
- **b** - Seawater Pump Pulley
- **c** - Crankshaft Pulley
- **d** - Circulating Pump Pulley
- **e** - Alternator Pulley
- **f** - Power Steering Pulley

## Inspection

**⚠ WARNING**

**Avoid possible serious injury. Ensure that the engine is shut off and the ignition key is removed before inspecting the belt.**

1. Inspect the drive belt for the following:

- Excessive wear
- Cracks

***NOTE:*** Minor, transverse cracks (across the belt width) may be acceptable. Longitudinal cracks (in the direction of belt length) that join transverse cracks are NOT acceptable.

- Fraying
- Glazed surfaces
- Proper tension - 6 mm (1/4 in.) deflection, with moderate thumb pressure, on the belt at the location that has the longest distance between two pulleys.

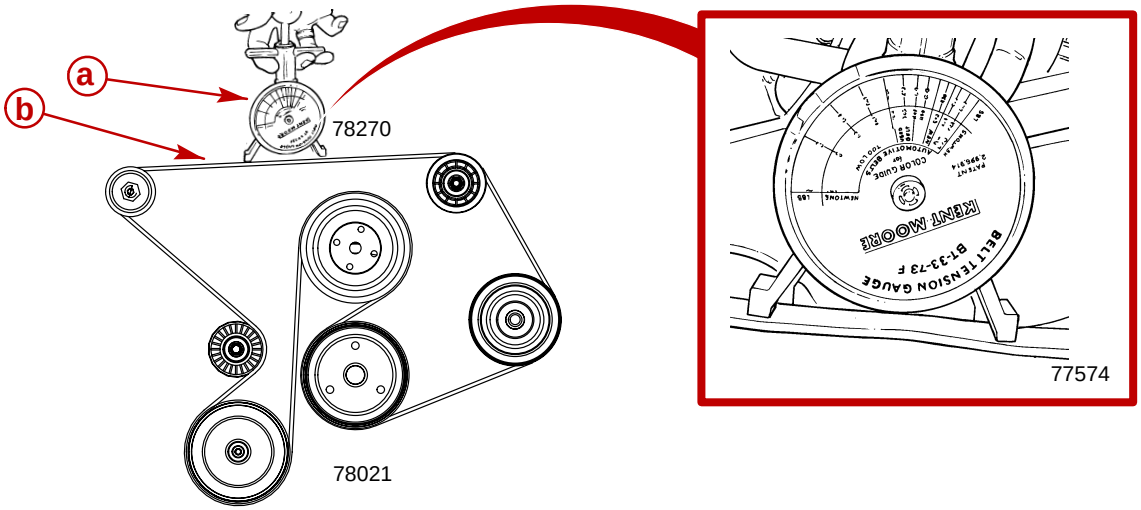
# Replacing Belt and/or Adjusting Tension

## REMOVAL

1. Loosen the 5/8 in. locking nut on the adjustment stud.
2. Turn the adjustment stud and loosen the belt.
3. Remove the serpentine drive belt.

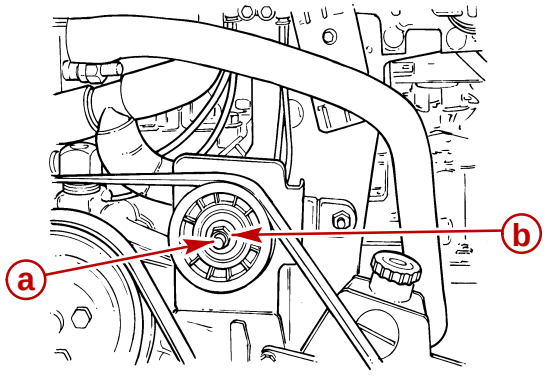
## INSTALLATION AND ADJUSTMENT

1. Install the serpentine drive belt onto the pulleys.
2. Put a wrench on the adjustment stud 5/8 in. locking nut.
3. Use a 5/16 in. socket and tighten adjusting the stud to adjust the belt deflection.
4. Ensure that the correct deflection has been obtained.
   a. Push down with moderate thumb pressure on the longest stretch of belt.
   b. Attach the Kent Moore Belt Tension Gauge to the belt. The gauge has different ranges for new and used belts.




**a** - Kent Moore Tension Gauge
**b** - Serpentine Belt

5. While holding the adjustment stud at the correct belt tension, tighten the 5/8 in. locking nut.




**a** - 5/8 in. Locking Nut
**b** - 5/16 in. Adjusting Stud

6. Operate the engine for a short period of time and recheck the belt adjustment.

# Exhaust System

***NOTE:*** *Refer to SECTION 7.*

1. Ensure that all hose clamps are tight and connections are secure.
2. Inspect the entire system for damage or leaks.

# Seawater Pump

***NOTE:*** *Refer to SECTION 6A.*

1. Inspect the seawater pump components; replace as necessary.

# Cold Weather And Extended Storage

**IMPORTANT: Mercury MerCruiser strongly recommends that this service should be performed by an authorized Mercury MerCruiser dealer. Damage caused by freezing IS NOT covered by the Mercury MerCruiser Limited Warranty.**

**⚠ CAUTION**

**Sterndrive unit should be stored in the full DOWN position. Universal joint bellows may develop a "set" if unit is stored in raised position and may fail when unit is returned to service.**

**IMPORTANT: Mercury MerCruiser recommends that propylene glycol antifreeze (a nontoxic and environmentally safe antifreeze) be used in the seawater section of the cooling system for cold weather or extended storage. Ensure that the propylene glycol antifreeze contains a rust inhibitor and is recommended for use in marine engines. Be certain to follow the propylene glycol manufacturer's recommendations.**

**⚠ CAUTION**

**The seawater section of the cooling system MUST BE COMPLETELY drained for winter storage, or immediately after cold weather use, if the possibility of freezing temperatures exist. Failure to comply may result in trapped water causing freeze and/or corrosion damage to the engine. Damage caused by freezing is NOT covered by the Mercury MerCruiser Limited Warranty.**

## Preparing Your Power Package For Storage

1. Fill the fuel tanks with fresh gasoline (that does not contain alcohol) and a sufficient amount of Mercury Fuel System Treatment and Stabilizer to treat the gasoline. Follow instructions on the container.
2. **If the boat is to be placed in storage with fuel containing alcohol in fuel tanks (if fuel without alcohol is not available):** Fuel tanks should be drained as low as possible and Quicksilver Gasoline Stabilizer for Marine Engines added to any fuel remaining in the tank.

***NOTE:*** *If desired, a portable fuel tank can be used to perform the remainder of the power package lay up procedures. Be sure to add an appropriate amount of Gasoline Stabilizer to the portable tank.*

3. Flush the cooling system.
4. Change the oil and oil filter.

## FUEL SYSTEM

**⚠ WARNING**

**The fuel injection system is pressurized. Avoid serious injury from an explosion. Use care when removing water separating fuel filter. Allow engine to cool down before removing the water separating fuel filter. Also, hold a clean shop towel over the water separating fuel filter when removing it, to help avoid fuel spraying on the engine.**

**⚠ WARNING**

**Fuel vapors can be present in the engine compartment. Avoid injury or power package damage caused by fuel vapors or explosion. Always ventilate the engine compartment prior to servicing the power package.**

1. In a 23 l (6 U.S. gal) remote fuel tank mix:
   a. 19 l (5 U.S. gal) regular unleaded 87 octane (90 RON) gasoline
   b. 1.89 l (2 U.S. qts.) Premium Plus 2-Cycle TC-W3 Outboard Oil
   c. 150 ml (5 ounces) Fuel System Treatment and Stabilizer or 30 ml (1 ounce) Fuel System Treatment and Stabilizer Concentrate.

| Description | Where Used | Part Number |
|---|---|---|
| Mercury Fuel System Treatment and Stabilizer | Fuel System | 92-802875A1 |
| Mercury Fuel System Treatment and Stabilizer Concentrate | Fuel System | 92-802876A1 |
| Premium Plus 2-Cycle TC-W3 Outboard Oil | Fuel System | 92-802824A1 |

2. Allow the engine to cool down.
3. Activate the Schrader valve to relieve fuel pressure.
4. Close the fuel shut-off valve, if equipped. Disconnect and plug the fuel inlet fitting if not equipped with a fuel shut-off valve.
5. Connect the remote fuel tank (with the fogging mixture) to the fuel inlet fitting.

**IMPORTANT: Supply cooling water to the engine.**

6. Start and operate the engine at 1300 rpm for 5 minutes.
7. After specified operating time is complete, slowly return throttle to idle rpm and shut engine off.

**IMPORTANT: Ensure that some fogging mixture remains in the engine. Do NOT allow the engine's fuel system to become completely dry.**

8. Remove and discard the water separating fuel filter.
9. Install a new filter.

## BATTERY

Follow the battery manufacturer's instructions for storage.

# Draining Instructions

**⚠ CAUTION**

**Ensure that boat is out of the water or seacock is closed and bilge pump is operating before beginning procedure. Excess water in bilge can damage engine or cause boat to sink.**

**⚠ CAUTION**

**Do not operate engine with drain system open. Excess water in bilge can damage engine or cause boat to sink.**

**IMPORTANT: Boat must be as level as possible to ensure complete draining of cooling system.**

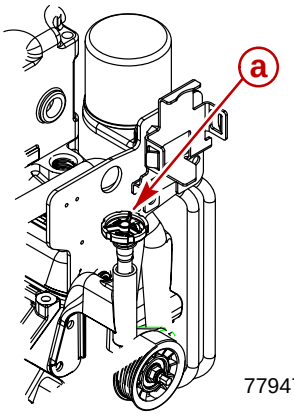
Your power package is equipped with one of three drain systems. Refer to Identification on the following page to determine which instructions apply to your power package.

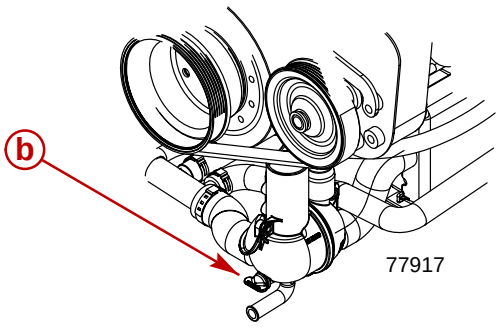
The power package should be drained before flushing or prior to extended or cold weather storage.

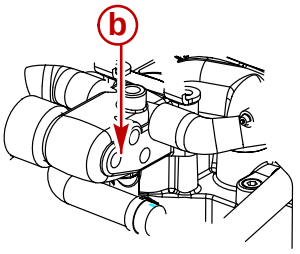
**IMPORTANT: The boat must not be operating at any point during this procedure.**

# Identification

## MANUAL SINGLE POINT DRAIN SYSTEM

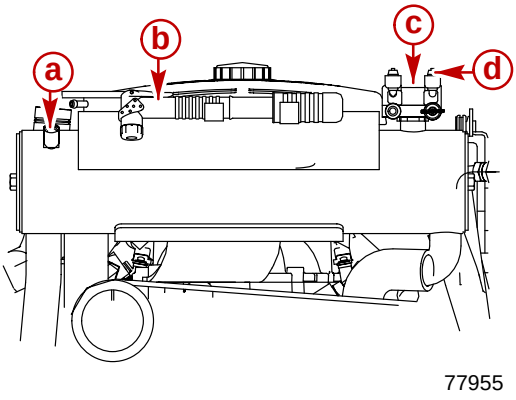


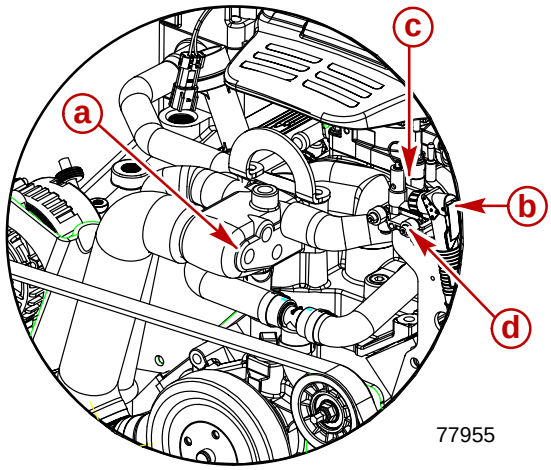




**a** - Blue Handle
**b** - Blue Drain Plug Location

## AIR ACTUATED SINGLE POINT DRAIN SYSTEM

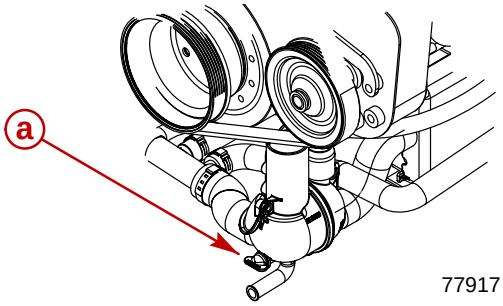


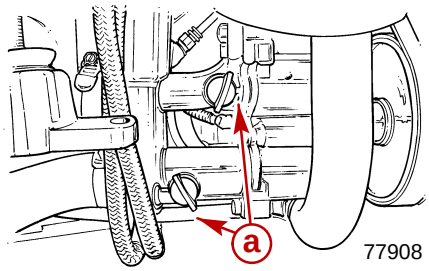




**Closed Cooled Models** **Seawater Cooled Models**

**a** - Blue Drain Plug Location
**b** - Blue Air Pump
**c** - Air Manifold
**d** - Green Indicators

## 3 POINT MANUAL DRAIN SYSTEM



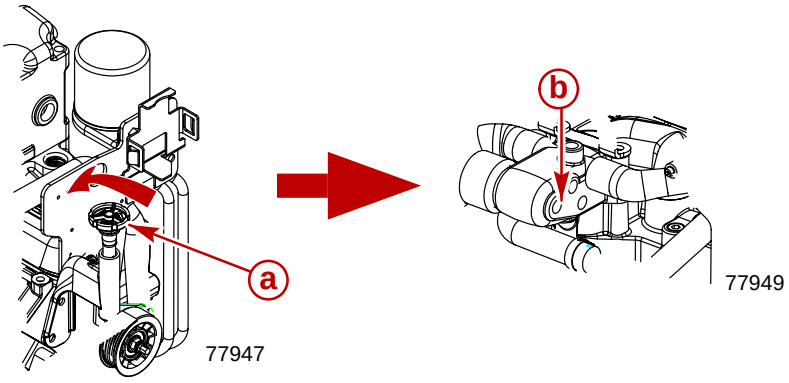




**a** - Blue Drain Plug

# Boat In The Water

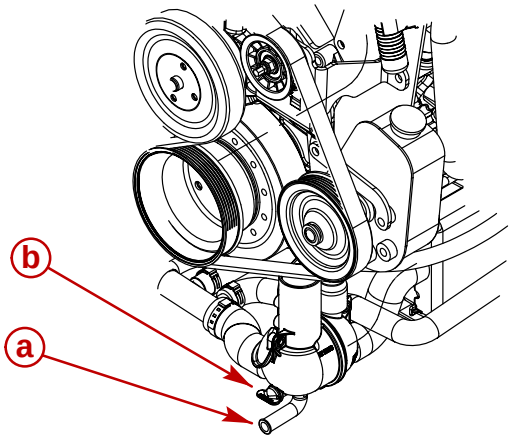
## MANUAL SINGLE POINT DRAIN SYSTEM

1. Close the seacock.
2. Rotate the blue handle COUNTERCLOCKWISE until it stops (approximately 2 turns). The red on the handle shaft indicates that the drain system is open. Do not force the handle as this will create new threads.
3. **Immediately** remove the blue drain plug from the side of the thermostat housing. This must be removed within 30 seconds to properly vent the cooling system.




**a -** Blue Handle
**b -** Blue Drain Plug Location

4. Visually verify that water is draining. If water does not drain, remove blue drain plug from distribution housing and drain manually.



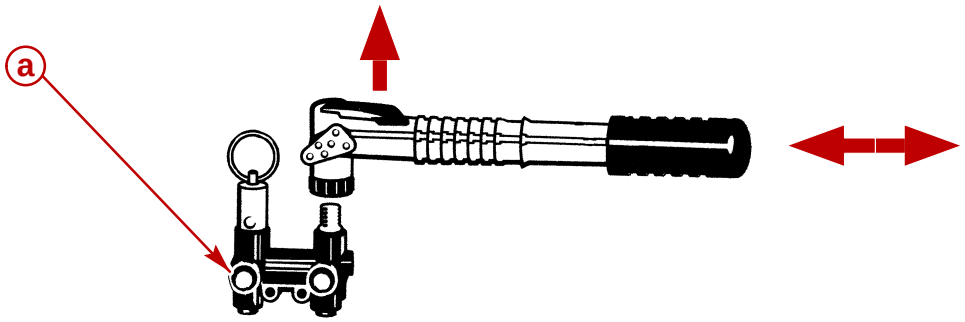

**a -** Drain Location - Orange Or Red
**b -** Blue Drain Plug

5. Allow the system to drain for a minimum of 5 minutes. Mercury MerCruiser recommends leaving the drain system open while transporting the boat or while performing other maintenance.
6. Reinstall the blue drain plug in the thermostat housing.
7. Close the drain system by rotating the blue handle CLOCKWISE until it stops and install the blue drain plug, if removed. The handle is fully seated when no red is visible. Do not overtighten the handle as this will create new threads.
8. Open the seacock prior to operating the engine.

## AIR ACTUATED SINGLE POINT DRAIN SYSTEM

***NOTE:*** *This procedure is written for the air pump that is attached to the engine. However, any air source can be used.*

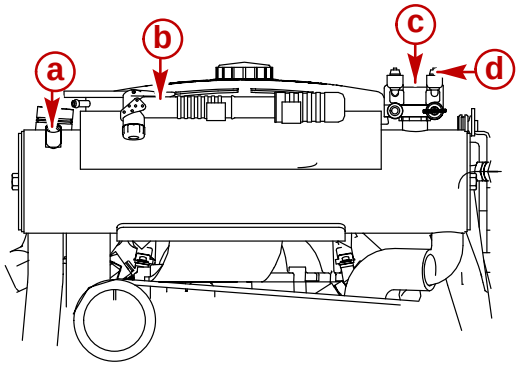
1. Close the seacock.
2. Remove the blue air pump from the engine.
3. Ensure that lever on top of pump is flush with the handle (horizontal).
4. Install the air pump on the fitting in the air manifold.




77638

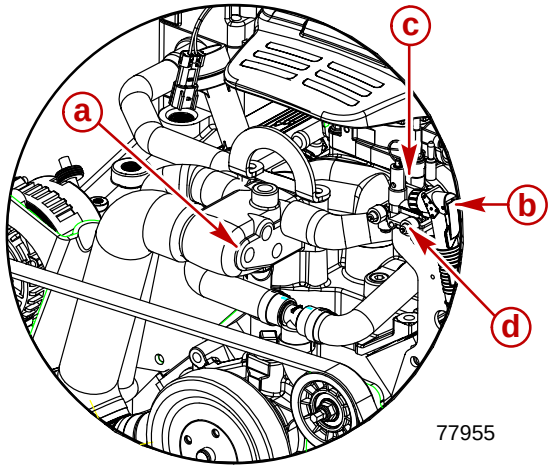
**a -** Green Indicators

5. Pull lever on the air pump up (vertical) to lock pump on the fitting.
6. Pump air into the system until both green indicators extend and water drains from both sides of the engine. The port side will begin draining before the starboard side.
7. **Immediately** remove the blue drain plug from the side of the thermostat housing or the heat exchanger. This must be removed within 30 seconds to properly vent the cooling system.




77955

**Closed Cooled Models**

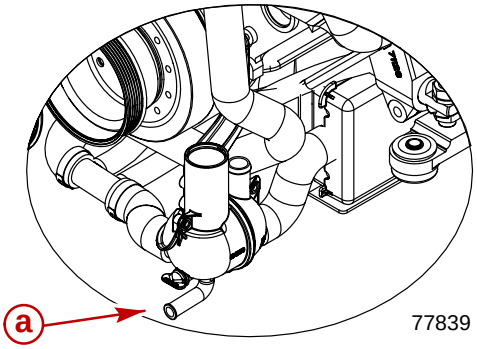



77955

**Seawater Cooled Models**

**a -** Blue Drain Plug Location
**b -** Blue Air Pump
**c -** Air Manifold
**d -** Green Indicators

8. Verify that water is draining from each opening. If not, use the 3 Point Manual Drain System instructions.



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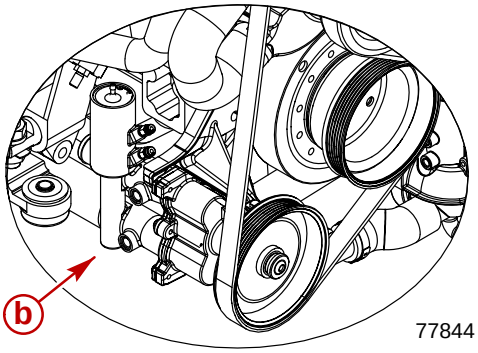
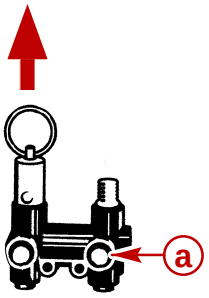


77844

**a** - Port Side Drain Location
**b** - Starboard Side Drain Location

9. Allow the system to drain for a minimum of 5 minutes. Add air as necessary to keep the green indicators extended.
10. Crank engine over slightly with starter motor to purge any water trapped in seawater pump. Do NOT allow engine to start.
11. Reinstall the blue drain plug in the thermostat housing.
12. Remove the air pump from the air manifold and return it to the mounting bracket.
13. Mercury MerCruiser recommends leaving the drain system open while transporting the boat or while performing other maintenance. This helps ensure that all water is drained.
14. Before launching boat, pull up on manual release valve. Verify that green indicators are no longer extended.



77638

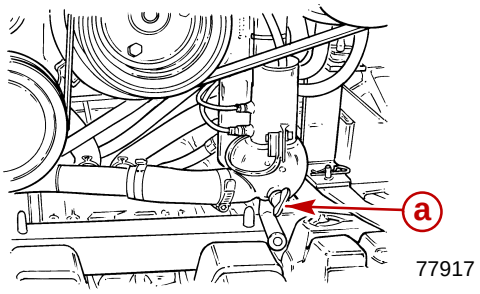
**a** - Green Indicators

15. Open the seacock prior to operating the engine.

## 3 POINT MANUAL DRAIN SYSTEM

***NOTE:*** *Use this procedure if your engine is not equipped with an air actuated single point drain system or if the single point drain system fails.*

1. Close the seacock.
2. Remove three blue drain plugs: One from the distribution housing (lower front, port side) and two from the seawater pickup pump (front, starboard side).



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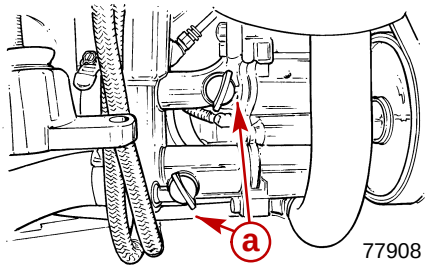
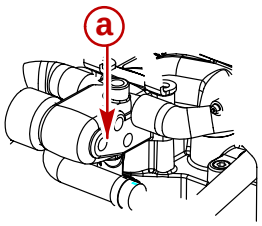


77908

**a -** Blue Drain Plugs

3. **Immediately** remove the blue drain plug from the side of the thermostat housing. This must be removed within 30 seconds to properly vent the cooling system.



77949

**a -** Blue Drain Plug Location

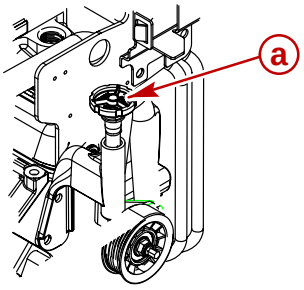
4. Verify that water is draining from each opening.
5. Allow the system to drain for a minimum of 5 minutes. Mercury MerCruiser recommends leaving the drain system open while transporting the boat or while performing other maintenance.
6. Crank engine over slightly with starter motor to purge any water trapped in seawater pickup pump. Do NOT allow the engine to start.
7. Prior to launching boat or starting the engine, close the drain system by installing the four blue drain plugs.
8. Open the seacock prior to operating the engine.

# Boat Out Of The Water

**IMPORTANT: Boat must be as level as possible to ensure complete draining.**

## MANUAL SINGLE POINT DRAIN SYSTEM

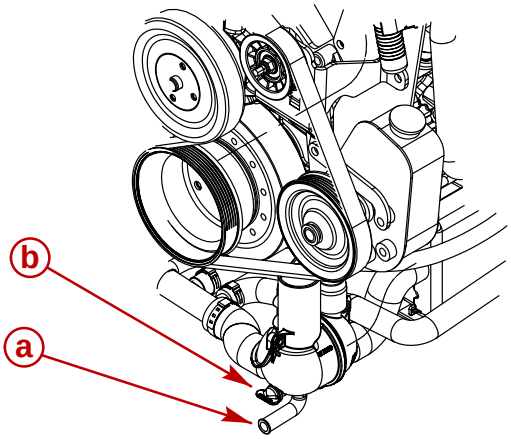
1. Rotate the blue handle COUNTERCLOCKWISE until rotation stops (approximately 2 turns). The red on the handle shaft indicates that the drain system is open. Do not force the handle as this will create new threads.




77947

**a -** Blue Handle

2. Visually verify that water is draining. If water does not drain, remove blue drain plug from distribution housing and allow to drain manually.




77917

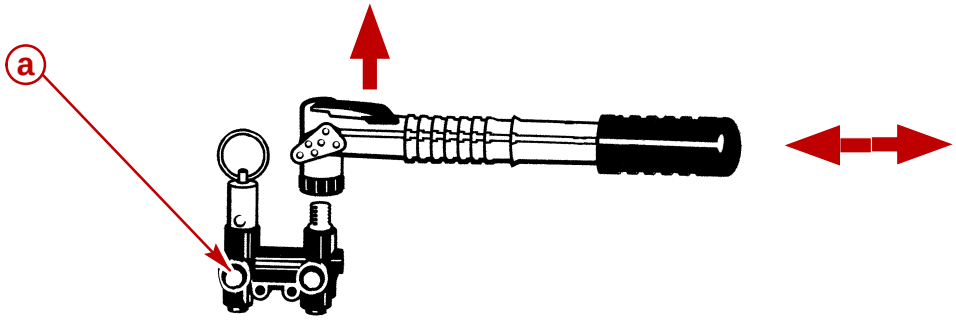
**a -** Drain Location - Orange Or Red
**b -** Blue Drain Plug

3. Allow the system to drain for a minimum of 5 minutes. Mercury MerCruiser recommends leaving the plugs out while transporting the boat or while performing other maintenance to ensure that all water is drained.
4. Close the drain system by rotating the blue handle CLOCKWISE until it stops or installing the blue drain plug. The handle is fully seated when no red is visible. Do not overtighten the handle as this will create new threads.

## AIR ACTUATED SINGLE POINT DRAIN SYSTEM

***NOTE:*** *This procedure is written for the air pump that is attached to the engine. However, any air source can be used.*

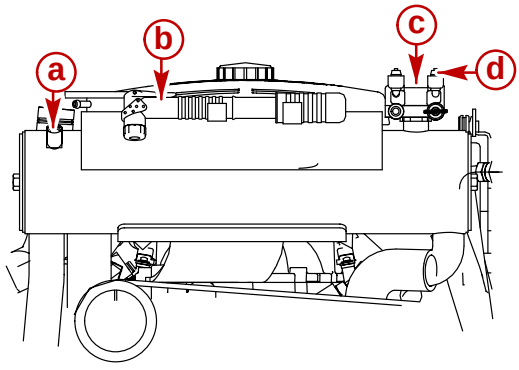
1. Remove the blue air pump from the engine.
2. Ensure that lever on top of pump is flush with the handle (horizontal).
3. Install the air pump on the fitting in the air manifold.




77638

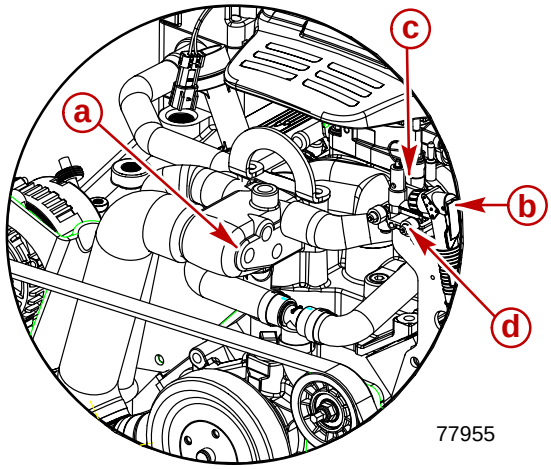
**a** - Green Indicators

4. Pull the lever on the air pump up (vertical) to lock the pump on the fitting.
5. Pump air into the system until both green indicators extend and water drains from both sides of the engine. The port side will begin draining before the starboard side.




77955

**Closed Cooled Models**

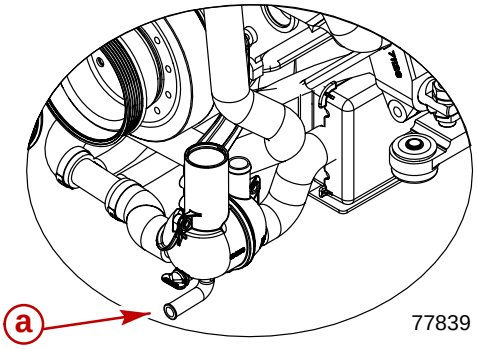



77955

**Seawater Cooled Models**

**a** - Blue Drain Plug Location
**b** - Blue Air Pump
**c** - Air Manifold
**d** - Green Indicators

6. Verify that water is draining from each opening. If not, use the 3 Point Manual Drain System.



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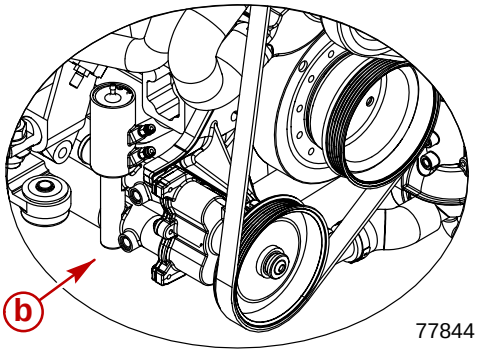
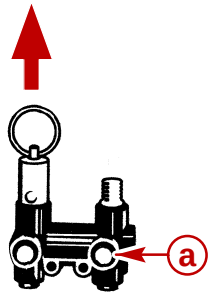


77844

**a** - Port Side Drain Location
**b** - Starboard Side Drain Location

7. Allow the system to drain for a minimum of 5 minutes. Add air as necessary to keep the green indicators extended.
8. Crank engine over slightly with starter motor to purge any water trapped in seawater pump. Do NOT allow engine to start.
9. Remove the air pump from the air manifold and return it to the mounting bracket.
10. Mercury MerCruiser recommends leaving the plugs out while transporting the boat or while performing other maintenance to ensure that all water is drained.
11. Before launching boat, pull up on the manual release valve. Verify that the green indicators are no longer extended.



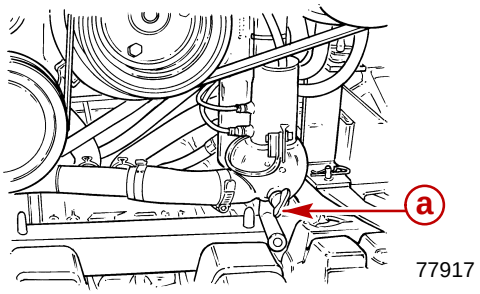
77638

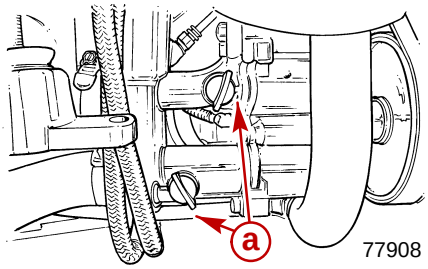
**a** - Green Indicators

### 3 POINT MANUAL DRAIN SYSTEM

***NOTE:*** *Use this procedure if your engine is not equipped with an air actuated single point drain system or if the single point drain system fails.*

1. Remove three blue drain plugs: One from the distribution housing (lower front, port side) and two from the seawater pickup pump (front, starboard side).




**a** - Blue Drain Plug

2. Verify that water is draining from each opening.
3. Allow the system to drain for a minimum of 5 minutes. Mercury MerCruiser recommends leaving the plugs out while transporting the boat or while performing other maintenance to ensure that all water is drained.
4. Crank engine over slightly with starter motor to purge any water trapped in seawater pickup pump. Do NOT allow engine to start.
5. Prior to launching boat or starting the engine, close the drain system by re-installing the three blue drain plugs.

## All Models

1. For additional assurance against freezing and corrosion, fill the cooling system with a mixture of propylene glycol antifreeze and tap water mixed to manufacturer's recommendation to protect engine to the lowest temperature to which it will be exposed during cold weather or extended storage.
   a. Remove thermostat housing or hose and fill with propylene glycol coolant until engine block is full. If thermostat housing was removed, reinstall and tighten cover bolts securely.

Store boat with drive unit in full DOWN/IN position.

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# IMPORTANT INFORMATION

## Section 1C - Troubleshooting

1 C

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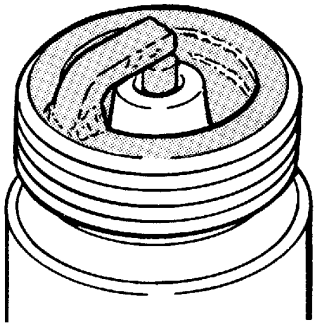
# Used Spark Plug Analysis

Spark plug condition can suggest a variety of possible engine malfunctions and indicate needed engine repairs. When the old plugs are replaced, replace the entire set. Perform plug service only on those plugs suitable for additional service, using the following procedures:

1. Remove any oil deposits with solvent and dry plugs thoroughly.
2. Open the electrode gap wide enough to permit cleaning and filing.
3. Remove the combustion deposits from the firing end of the spark plug with a plug cleaner. Use compressed air to remove abrasives.
4. File the electrode surfaces to restore clean, sharp edges. Remove filings with compressed air.
5. Reset the gap to specifications by bending only the side electrode with the proper tool.

## Normal Condition

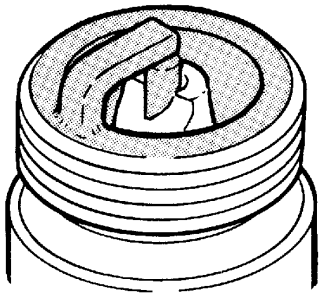
Few deposits are present and probably will be light tan or gray in color. This plug shows that the plug heat range is compatible with the engine, and the engine is electrically and mechanically in good running condition. With proper plug servicing (clean, file and regap), this plug can be reinstalled with good results.



72420

## Chipped Insulator

A chipped insulator usually results from careless plug regapping. Under certain conditions, severe detonation also can split the insulator firing ends. Replace the spark plugs.

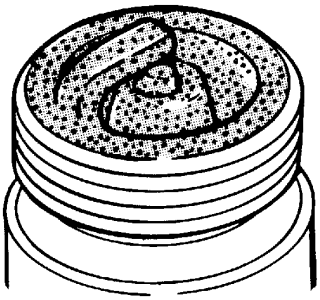


72420

## Wet Fouling (Oil Deposits)

The plug becomes shorted by excessive oil entering the combustion chamber, usually in the engine with many hours of operation. Worn piston rings, cylinder walls, valve guides or valve stem seals are causes of oil entering the combustion chamber. Only engine repairs will permanently relieve oil wet fouling.

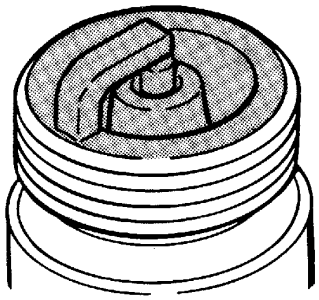
**IMPORTANT: New engines or recently overhauled engines may wet foul the plugs before normal oil control is achieved with proper break-in procedures. Such fouled plugs may be serviced (clean, file and regap) and reinstalled.**



72420

## Cold Fouling

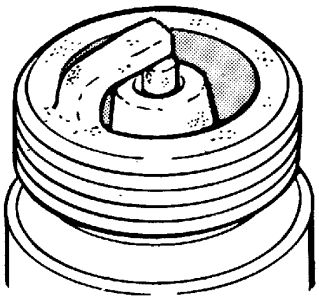
Dry, black deposits indicate a rich fuel mixture or a weak ignition. A clogged flame arrestor, a flooding engine, a sticky choke or weak ignition components all are probable causes. If, however, only one or two plugs in the set are fouled, check for sticking valves or bad ignition leads. After correcting the cause, service (clean, file and regap) plugs and reinstall.



72421

## Overheating

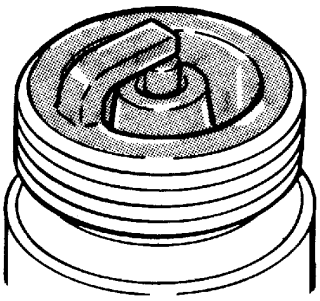
The insulator is dull white or gray and appears blistered. The electrodes are eroded and there is an absence of deposits. Check that the correct plug heat range is being used. Also check for incorrect rotor location, cooling system malfunction, lean fuel/air mixtures, leaking intake manifold or sticking valves. Replace the spark plugs.



72421

## High Speed Glazing

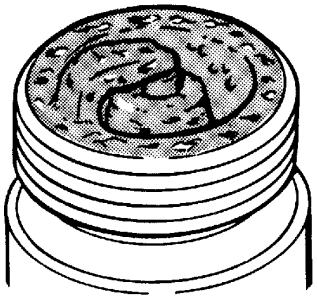
The insulator has yellowish, varnish-like color, indicating that the temperatures suddenly have risen, usually during hard, fast acceleration under heavy load. Normal deposits do not get a chance to blow off. Instead, they melt and form a conductive coating. Replace the spark plugs. If the condition recurs, use colder heat range plug and service plugs more frequently.



72421

## Scavenger Deposits

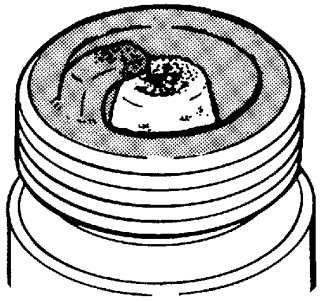
Powdery white or yellow deposits are built up on the shell, the insulator and the electrodes. This is the normal appearance with certain branded fuels. Accumulation on the ground electrodes and the shell areas may be unusually heavy, but may be easily chipped off. The plugs can be serviced (clean, file and regap) and reinstalled.



72422

## Pre-Ignition Damage

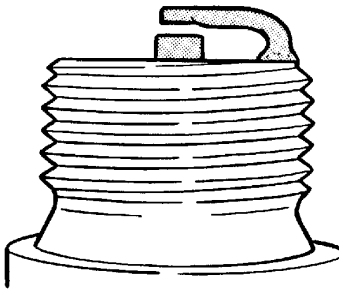
Pre-ignition damage is caused by excessive high temperatures. The center electrode melts first, followed by the ground electrode. Normally, the insulators are white but may be dirty if the plug has been misfiring. Check for the correct plug heat range, incorrect rotor location, lean fuel mixture, incorrect fuel used, malfunctioning cooling system, leaking intake manifold or lack of lubrication. Replace the spark plugs.



72422

## Reversed Coil Polarity

Concave erosion of the ground electrode is an indication of reversed polarity. The center electrode will show only normal wear. The engine will misfire and idle rough. To correct, reverse the primary coil leads. Replace the spark plugs.



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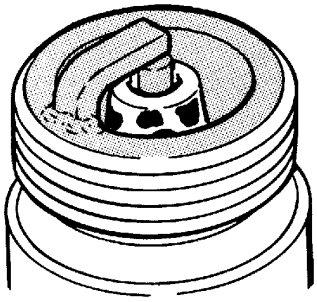
## Splashed Deposits

Spotted deposits, which sometimes occur after long delayed tune-up, accumulate after a long period of misfiring. When normal combustion temperatures are restored, upon the installation of the new plugs, the deposits loosen from the top of the piston and the head and are thrown against the hot insulator. The plugs can be serviced (clean, file and regap) and reinstalled.



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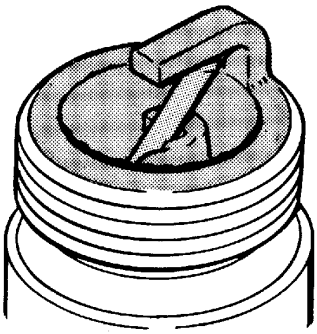
## Mechanical Damage

Mechanical damage to the spark plug firing end is caused by a foreign object in the combustion chamber. Because of valve overlap, small objects can travel from one cylinder to another. Check all cylinders, the intake manifold and the exhaust material to prevent further damage. Replace the spark plugs.



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**IMPORTANT: When working on the engine, the spark plug holes, the intake and the throttle body should be kept covered to prevent foreign objects from entering the combustion chamber.**

# Poor Boat Performance And/Or Poor Maneuverability

| Symptom | Cause | Action |
|---|---|---|
| **1. Bow too low** | **1.0** Improper drive unit trim angle | **1.0** Trim the drive to the appropriate angle. |
| | **1.1** Improper weight distribution | **1.1** Distribute the weight evenly. |
| | **1.2** The boat is underpowered | **1.2** Replace propeller. If the problem persists, contact the manufacturer regarding the correct power package. |
| | **1.3** Permanent or power hook in the boat bottom | **1.3** Correct the boat bottom. |
| | **1.4** False bottom full of water | **1.4** Siphon the water from the false bottom. Determine the cause of the excess water. |
| | **1.5** Dirty boat bottom (marine growth) | **1.5** Clean the boat bottom. |
| **2. Bow too high** | **2.0** Improper drive unit trim angle | **2.0** Trim the drive to the appropriate angle. |
| | **2.1** Propeller pitch too high | **2.1** Replace with a lower pitch propeller. |
| | **2.2** Marine growth on boat bottom | **2.2** Clean the boat bottom. |
| | **2.3** Poorly operating engine | **2.3** Tune the engine. |
| | **2.4** Improper weight distribution | **2.4** Distribute the weight evenly. |
| | **2.5** Rocker in the boat bottom | **2.5** Correct the boat bottom. |
| | **2.6** False bottom full of water | **2.6** Siphon the water from the false bottom. Determine the cause of the excess water. |

# Poor Boat Performance And/Or Poor Maneuverability (continued)

| Symptom | Cause | Action |
|---|---|---|
| **3. Propeller ventilation** | **3.0** Dirty or rough boat bottom | **3.0** Clean the boat bottom. |
| | **3.1** Damaged propeller; pitch too small; diameter too small | **3.1** Replace the propeller. |
| | **3.2** Water pickup or through the hull fittings located too close to the propeller | **3.2** Remove the water pickup or the through the hull fittings. Repair the hull. Reinstall the water pickup or the through the hull fittings in the proper locations. |
| | **3.3** Hook in boat bottom | **3.3** Repair the boat bottom. |
| | **3.4** Propeller plugged up with weeds | **3.4** Clean the propeller. |
| | **3.5** Keel located too close to the propeller or too deep in the water | **3.5** Repair the hull. |
| | **3.6** Drive unit installed too high on the transom | **3.6** Remove the drive unit. Repair the transom. Reinstall the drive unit in the proper position. |

# Improper Full Throttle Engine RPM

| Symptom | Cause | Action |
|---|---|---|
| **1. Full throttle engine rpm too high** | **1.0** Propeller damaged, pitch too low, diameter too small, propeller hub slipping | **1.0** Replace the propeller. |
| | **1.1** Water pickup or through the hull fittings mounted too close to the propeller (ventilation) | **1.1** Remove the water pickup or through the hull fittings. Repair the hull. Reinstall the water pickup or the through the hull fittings in the proper locations. |
| | **1.2** Drive unit trimmed out too far | **1.2** Trim the drive unit to the appropriate angle. |
| | **1.3** Keel located too close to the propeller and/or too deep in the water | **1.3** Repair the hull. |
| | **1.4** Drive installed too high on the transom | **1.4** Remove the drive unit. Repair the transom. Reinstall the drive unit in the proper position. |
| | **1.5** Wrong gear ratio drive unit | **1.5** Replace the drive unit with the appropriate gear ratio. |
| **2. Full throttle engine rpm too low** | **2.0** Propeller damaged, pitch too great, diameter too great | **2.0** Replace the propeller. |
| | **2.1** Drive unit trimmed in too far | **2.1** Trim the drive unit to the appropriate angle. |
| | **2.2** Dirty boat bottom | **2.2** Clean the boat bottom. |
| | **2.3** Damaged boat bottom | **2.3** Repair the boat bottom. |
| | **2.4** Permanent or power hook in bottom | **2.4** Repair the boat bottom. |
| | **2.5** False bottom full of water | **2.5** Siphon the water from the false bottom. Determine the cause of the excess water. |
| | **2.6** Drive unit installed too low on the transom | **2.6** Remove the drive unit. Repair the transom. Reinstall the drive unit in the proper position. |
| | **2.7** Wrong gear ratio drive unit | **2.7** Replace the drive unit with the appropriate gear ratio. |

# Engine Cranks Over But Will Not Start Or Starts Hard

## Important Information

1. First, determine which engine system is causing the problem. To make an engine operate, basic components - fuel, spark (ignition), and compression - are required. If all three components are present, the engine should operate. If any one of the three are missing, weak or arriving at the wrong time, the engine will not operate.
2. Determine if any faults are present by using a diagnostic tool. If faults are present, correct the fault before proceeding.
3. Determine if there is fuel present at the Schrader valve just behind the throttle body.
4. Remove the spark plugs and make sure they are the correct type and heat range, and not fouled or burned.
5. Run a compression check on the engine to make sure the engine is mechanically acceptable.

| Symptom | Cause | Action |
|---|---|---|
| **1. Engine cranks over but will not start or starts hard** | **1.0** Clogged flame arrestor | **1.0** Clean the flame arrestor. |
| | **1.1** Excessive fuel pump pressure | **1.1** Determine the cause of the excess pressure and repair. |
| | **1.2** Empty fuel tank | **1.2** Fill the fuel tank. |
| | **1.3** Fuel shut off valve closed | **1.3** Open the fuel shut off valve. |
| | **1.4** Vapor lock | **1.4** Refer to Vapor Lock Condition. |
| | **1.5** Fuel system lean | **1.5** Clean fuel system. |
| | **1.6** Low grade or stale fuel | **1.6** Drain the fuel tank and refill. |
| | **1.7** Water in fuel | **1.7** Treat the contaminated fuel with appropriate fuel treatment. If the problem persists, drain the fuel tank and refill. |

# Engine Will Not Crank Over

| Symptom | Cause | Action |
|---|---|---|
| **1. Engine will not crank over.** | **1.0** Remote control lever not in neutral position | **1.0** Place the remote control lever in NEUTRAL and try the ignition again. If the problem persists, check the remote control level NEUTRAL detent setting. |
| | **1.1** Battery charge low, damaged wiring, loose electrical connections | **1.1** Check the electrical connections at the starter.<br>Check the battery cable connections.<br>Check the battery charge and recharge if necessary. |
| | **1.2** Circuit breaker tripped | **1.2** Reset the circuit breaker. |
| | **1.3** Blown fuse | **1.3** Replace the fuse. |
| | **1.4** Ignition switch faulty | **1.4** Replace the ignition switch. |
| | **1.5** Slave solenoid faulty | **1.5** Replace the slave solenoid. |
| | **1.6** Faulty neutral start safety switch | **1.6** Replace the neutral start safety switch. |
| | **1.7** Starter solenoid faulty | **1.7** Replace the starter solenoid. |
| | **1.8** Starter motor faulty | **1.8** Replace the starter motor. |
| | **1.9** Mechanical engine malfunction | **1.9** Determine the cause of the malfunction and repair. |
| | **1.10** Lanyard stop switch activated | **1.10** Deactivate the lanyard stop switch |

# Charging System Inoperative

| Symptom | Cause | Action |
|---|---|---|
| **1. Charging system inoperative** | **1.0** Loose or broken drive belt | **1.0** Replace the serpentine drive belt. |
| | **1.1** Engine rpm too low on initial start | **1.1** Accelerate the engine to 1500 rpm. |
| | **1.2** Loose or corroded electrical connections | **1.2** Check the electrical connections. |
| | **1.3** Faulty battery gauge | **1.3** Replace the gauge. |
| | **1.4** Battery will not accept charge | **1.4** Check the electrolyte level and fill if necessary. Replace the battery. |
| | **1.5** Faulty alternator or regulator | **1.5** Test the alternator and the regulator and replace if necessary. |

# Noisy Alternator

| Symptom | Cause | Action |
|---|---|---|
| **1. Noisy alternator** | **1.0** Loose mounting bolts | **1.0** Tighten the mounting bolts. |
| | **1.1** Drive belt | **1.1** Replace the serpentine drive belt. |
| | **1.2** Loose drive pulley | **1.2** Tighten the pulley. |
| | **1.3** Worn or dirty bearings | **1.3** Replace the bearings. |
| | **1.4** Faulty diode trio or stator | **1.4** Replace the alternator. |

# Instrumentation Malfunction

| Symptom | Cause | Action |
|---|---|---|
| **1. Instrumentation Malfunction** | **1.0** Faulty wiring, loose or corroded terminals | **1.0** Check the electrical connections. |
| | **1.1** Faulty key switch | **1.1** Replace the key switch. |
| | **1.2** Faulty gauge | **1.2** Replace the gauge. |
| | **1.3** Faulty sender | **1.3** Replace the sender. |

# Radio Noise

| Symptom | Cause | Action |
|---|---|---|
| **1. A popping noise that will increase with engine rpm. Noise will stop as soon as engine is turned off** | **1.0** Wrong spark plugs | **1.0** Change the spark plugs. |
| | **1.1** Cracked distributor cap | **1.1** Check the distributor cap for cracks or marks. Replace the cap if necessary. |
| | **1.2** Cracked coil tower | **1.2** Check the ignition coil for cracks or corrosion. |
| | **1.3** Leaking spark plug wires | **1.3** Change the spark plug wires. |
| | **1.4** Moisture on ignition components | **1.4** Check all ignition components for corrosion. |
| **2. A high pitched whine in the radio** | **2.0** Alternator - poor brush contact on the slip rings | **2.0** Test the alternator. Replace if necessary. |
| **3. A hissing or crackling noise when instruments are jarred with ignition on** | **3.0** Instrumentation - loose connections or antennae wire routed too close to instruments | **3.0** Check the instrument harness connections.<br>Check the antennae routing. |
| **4. Varying unexplained noises** | **4.0** Accessories - bilge pump, bilge blower; fish finder, depth locator; cabin heater motor, etc. | **4.0** Disconnect the accessories one at a time until the noise disappears. Replace the faulty accessory. |

# Poor Fuel Economy

| Symptom | Cause | Action |
|---|---|---|
| **1.0 Poor fuel economy** | **1.0** Fuel leak | **1.0** Locate the leak and repair. |
| | **1.1** Operator habits - Prolonged idling, slow acceleration, failure to cut back on throttle once boat is on plane, boat overloaded, uneven weight distribution | **1.1** Educate the operator. |
| | **1.2** Engine laboring - Bent, damaged or wrong propeller | **1.2** Water test the boat for proper operating rpm at WOT. |
| | **1.3** Clogged flame arrestor | **1.3** Clean the flame arrestor. |
| | **1.4** Engine compartment sealed too tight | **1.4** Vent the engine hatch appropriately. |
| | **1.5** Boat bottom dirty (marine growth), hook, rocker | **1.5** Clean the boat bottom. |
| | **1.6** Improper fuel | **1.6** Drain the fuel tank and refill with the correct fuel. |
| | **1.7** Crankcase ventilation system clogged or dirty | **1.7** Clean the crankcase ventilation hoses. |
| | **1.8** Engine needs tune-up | **1.8** Change the spark plugs.<br>Check the distributor cap for cracks or marks. Replace the cap if necessary.<br>Check the ignition coil for cracks or corrosion.<br>Change the spark plug wires.<br>Check all ignition components for corrosion. |
| | **1.9** Engine running too cold or too hot | **1.9** Check the thermostat.<br>Check for kinked or restricted hoses.<br>Clean the cooling system. |
| | **1.10** Plugged or restricted exhaust | **1.10** Clean the exhaust system. |
| | **1.11** Low compression | **1.11** Perform the cylinder compression check to determine which cylinder has low compression.<br>Replace the rings, the valves or the pistons. |

# Engine Runs Poorly at Idle

| Symptom | Cause | Action |
|---|---|---|
| **1. Engine surges** | **1.0** Leaking idle air control (IAC), intake manifold or throttle body gaskets | **1.0** Find and replace the leaking gaskets. |
| | **1.1** Throttle valves worn or damaged | **1.1** Inspect the throttle valves.<br>Replace the throttle body if necessary. |
| | **1.2** Worn or leaking IAC hose or vacuum hose to the pressure regulator | **1.2** Find and replace the leaking hose. |
| **2. Low top speed or lack of power** | **2.0** Leaking IAC, intake manifold or throttle body gaskets | **2.0** Find and replace the leaking gaskets. |
| **3. Poor cold engine operation** | **3.0** Engine is not reaching normal operating temperature | **3.0** Replace thermostat or thermostat housing gasket. |
| | **3.1** Faulty engine temperature sensor (ECT) | **3.1** Replace the ECT. |
| | **3.2.** Fuel PSI too high or too low | **3.2** Determine the cause and repair. |
| | **3.3** Throttle valves worn or damaged | **3.3** Inspect the throttle valves.<br>Replace the throttle body if necessary. |
| | **3.4** Engine flooding | **3.4** Check the fuel pressure. If too high, find cause and correct.<br>Clean the flame arrestor.<br>Perform the cylinder balance test. |
| **4. Engine stalls** | **4.0** Idle rpm too low | **4.0** Clean the flame arrestor.<br>Test the IAC to see if it opens and closes properly. |
| | **4.1** Engine flooding | **4.1** Check the fuel pressure. If too high, find cause and correct.<br>Inspect the fuel pressure regulator.<br>Inspect the injectors. |
| | **4.2** Leaking idle air control (IAC), intake manifold or throttle body gaskets | **4.2** Find and replace the leaking gaskets. |
| **5.0 Engine misses** | **5.0** Fault in the ignition system | **5.0** Check the spark plugs.<br>Check the spark plug wires.<br>Check the distributor cap for cracks or marks.<br>Check the ignition coil operation.<br>Replace the faulty component. |

# Engine Runs Poorly At High RPM

| Symptom | Cause | Action |
|---|---|---|
| **1. Engine runs poorly at high rpm** | **1.0** Crankcase overfilled with oil | **1.0** Check the oil level with the boat at rest in the water. Drain the oil if necessary to obtain the correct level. |
| | **1.1** Anti-siphon valve restricting fuel supply | **1.1** Check fuel flow rates and repair, replace or remove anti-siphon valve as necessary. |
| | **1.2** Plugged fuel tank vent | **1.2** Clean the fuel tank vent. |
| | **1.3** Improper fuel supply | **1.3** Inspect fuel supply system. Repair or replace as necessary. |
| | **1.4** Incorrect rotor location | **1.4** Reset rotor location. |
| | **1.5** Low grade of fuel or water in the fuel | **1.5** Drain the fuel tank and refill with the correct fuel. |
| | **1.6** Spark plugs fouled, burned, cracked porcelain or incorrect heat range | **1.6** Inspect the spark plugs and service or replace. |
| | **1.7** Spark plug wires broken or poorly insulated | **1.7** Replace the spark plug wires. |
| | **1.8** Distributor cap or rotor dirty or cracked | **1.8** Inspect the distributor cap for cracks or marks. Replace the distributor cap and the rotor if necessary. |
| | **1.9** Coil damaged or malfunctioning | **1.9** Replace the coil. |
| | **1.10** Excessive play in distributor shaft | **1.10** Replace distributor. |
| | **1.11** Engine overheating | **1.11** Check cooling water supply or coolant level. |
| | **1.12** Low compression – worn valves, rings or seals | **1.12** Perform the cylinder compression check to determine which cylinder has low compression. Replace the rings, the valves or the pistons. |
| | **1.13** Restricted exhaust | **1.13** Clean the exhaust system. |

# Engine Acceleration Is Poor

| Symptom | Cause | Action |
|---|---|---|
| **1. Engine acceleration is poor** | **1.0** Incorrect rotor location | **1.0** Reset rotor location. |
| | **1.1** Incorrect distributor or amplifier advance curve | **1.1** Replace ECM. |
| | **1.2** Damaged distributor cap or rotor | **1.2** Inspect the distributor cap for cracks or marks. Replace the distributor cap and the rotor if necessary. |
| | **1.3** Vacuum leak | **1.3** Determine the source of the vacuum leak and repair. |
| | **1.4** Damaged spark plugs | **1.4** Inspect the spark plugs and service or replace. |
| | **1.5** Low compression | **1.5** Perform the cylinder compression check to determine which cylinder has low compression. Replace the rings, the valves or the pistons. |

# Troubleshooting with Vacuum Gauge

| Symptom | Cause | Action |
|---|---|---|
| **1. Steady reading between 381-533 mm (15-21 in.) at idle rpm** | **1.0** Normal | **1.0** No action necessary |
| **2. Extremely low reading, but steady at idle rpm** | **2.0** Vacuum leak, incorrect rotor location, underpowered boat, faulty boat bottom | **2.0** Determine the source of the vacuum leak and repair.<br>Remove and reinstall the distributor<br>Replace the propeller. If the problem persists, contact the manufacturer about the correct power package.<br>Repair the boat bottom. |
| **3. Fluctuates between high and low at idle rpm** | **3.0** Blown head gasket between two adjacent cylinders | **3.0** Determine the cause and replace the head gasket. |
| **4. Fluctuates 101-127 mm (4-5 in.) very slowly at idle rpm** | **4.0** Spark plug gap too narrow | **4.0** Inspect the spark plugs and service or replace if necessary. |
| **5. Fluctuates rapidly at idle, steadies as rpm is increased** | **5.0** Valve guides are worn | **5.0** Ream the valve guides and install a valve with an oversized stem or replace the cylinder head. |
| **6. Continuously fluctuates between low and normal reading at regular intervals at idle rpm** | **6.0** Burned or leaking valve | **6.0** Replace the valve. |

# Engine Noise

## Important Information

No definite rule or test will positively determine the source of engine noise. Use the following information only as a general guide to engine noise diagnosis.

1. Use a timing light to determine if the noise is timed with engine speed or 1/2 engine speed. Noises timed with engine speed are related to the crankshaft, rods, pistons, piston pins and flywheel. Noises timed to 1/2 engine speed are valve train related.
2. The use of a stethoscope can aid in locating a noise source; however, because noise will travel to other metal parts not involved in the problem, caution must be exercised.
3. If you believe the noise is confined to one particular cylinder, ground spark plug leads one at a time. If the noise lessens noticeably or disappears, it is isolated to that particular cylinder.
4. Try to isolate the noise to a location in the engine: front to back, top to bottom. This can help determine which components are at fault.
5. Sometimes noises can be caused by moving parts coming in contact with other components. Examples are: the flywheel or coupler; the exhaust flappers rattling against exhaust pipe; the crankshaft striking the oil pan, oil pan baffle or dipstick tube; the rocker arm striking the valve cover or a loose flywheel cover. In many cases, if this is found to be the problem a complete engine teardown is not necessary.
6. When the noise is isolated to a certain area and component, removal and inspection will be required. Refer to the appropriate sections of the service manual for the information required for service.
7. If the noise cannot be distinguished between the engine and the drive unit, remove the drive from the boat. Supplying water directly to the engine, operate the engine without the drive to determine whether the noise still occurs.

# Engine Noise (continued)

| Symptom | Cause | Action |
|---|---|---|
| **1. Engine noise in the valve cover area, timed to 1/2 engine speed, noise could be confined to one cylinder or may be found in any multitude of cylinders** | **1.0** Rocker arm striking cover | **1.0** Inspect the valve cover for damage. Replace if necessary. |
| | **1.1** Rocker arm out of adjustment | **1.1** Adjust the rocker arm. |
| | **1.2** Worn rocker arm | **1.2** Replace the rocker arm. |
| | **1.3** Bent push rod | **1.3** Replace the push rods. |
| | **1.4** Collapsed oil filter | **1.4** Replace the oil filter. |
| **2. Engine noise in cylinder area, may be confined to one cylinder or found in more than one cylinder, timed to engine speed** | **2.0** Sticking valve | **2.0** Inspect the valves and repair or replace. |
| | **2.1** Carbon build-up | **2.1** Inspect the internal engine components for carbon buildup. Clean or replace. |
| | **2.2** Connecting rod installed wrong | **2.2** Remove the connecting rods and install properly. |
| | **2.3** Bent connecting rod | **2.3** Replace the connecting rod. |
| | **2.4** Piston damaged or broken | **2.4** Inspect the piston. Replace if necessary. |
| | **2.5** Piston rings damaged or broken | **2.5** Inspect the piston rings. Replace if necessary. |
| | **2.6** Piston pin damaged or broken | **2.6** Inspect the piston pin. Replace if necessary. |
| | **2.7** Worn cylinder | **2.7** Inspect the cylinder. Bore as necessary. Replace the cylinders if necessary. |

# Engine Noise (continued)

| Symptom | Cause | Action |
|---|---|---|
| **3. Engine noise in camshaft area, front of the engine, timed to 1/2 engine speed** | **3.0** Crankshaft timing sprocket damaged | **3.0** Inspect the crankshaft timing sprocket. Replace if necessary. |
| | **3.1** Timing chain damaged | **3.1** Inspect the timing chain. Replace if necessary. |
| | **3.2** Fuel pump damaged | **3.2** Inspect the fuel pump. Replace if necessary. |
| | **3.3** Valve lifter damaged | **3.3** Inspect the valve lifter. Replace if necessary. |
| | **3.4** Cam bearings damaged | **3.4** Inspect the cam bearings. Replace if necessary. |
| **4. Engine noise in camshaft area, center of the engine, timed to 1/2 engine speed** | **4.0** Fuel pump damaged | **4.0** Inspect the fuel pump. Replace if necessary. |
| | **4.1** Valve lifter damaged | **4.1** Inspect the valve lifter. Replace if necessary. |
| | **4.2** Cam bearing damaged | **4.2** Inspect the cam bearings. Replace if necessary. |
| **5. Engine noise in camshaft area, rear of the engine, timed to 1/2 engine speed** | **5.0** Distributor gear damaged | **5.0** Inspect the distributor gear. Replace if necessary. |
| | **5.1** Valve lifter damaged | **5.1** Inspect the valve lifter. Replace if necessary. |
| | **5.2** Cam bearings damaged | **5.2** Inspect the cam bearings. Replace if necessary. |

# Engine Noise (continued)

| Symptom | Cause | Action |
|---|---|---|
| **6. Engine noise in camshaft area, throughout the engine, timed to 1/2 engine speed** | **6.0** Loss of oil pressure | **6.0** Check the crankcase oil level. If low, fill the crankcase and determine the cause of the oil loss.<br>Check for leaks.<br>Check the oil pressure gauge operation.<br>Check the oil pump operation. |
| | **6.1** Valve lifters damaged | **6.1** Inspect the valve lifters. Replace if necessary. |
| | **6.2** Cam bearings damaged | **6.2** Inspect the cam bearings. Replace if necessary. |
| **7. Engine noise in crankshaft area, front of the engine, timed to engine speed** | **7.0** Crankshaft timing sprocket damaged | **7.0** Inspect the crankshaft timing sprocket. Replace if necessary. |
| | **7.1** Timing chain damaged | **7.1** Inspect the timing chain. Replace if necessary. |
| | **7.2** Main bearing damaged | **7.2** Inspect the main bearing. Replace if necessary. |
| | **7.3** Rod bearing damaged | **7.3** Inspect the rod bearing. Replace if necessary. |
| **8. Engine noise in crankshaft area, center of the engine, timed to engine speed** | **8.0** Crankshaft striking the oil pan or the oil pan baffle | **8.0** Inspect the oil pan and the oil pan baffle. Repair or replace if necessary. |
| | **8.1** Main bearing damaged | **8.1** Inspect the main bearing. Replace if necessary. |
| | **8.2** Rod bearing damaged | **8.2** Inspect the rod bearing. Replace if necessary. |
| **9. Engine noise in crankshaft area, rear of the engine, timed to engine speed** | **9.0** Loose flywheel cover | **9.0** Tighten the flywheel cover fasteners. |
| | **9.1** Loose coupler | **9.1** Tighten the coupler fasteners. |
| | **9.2** Loose flywheel | **9.2** Tighten the flywheel fasteners. |
| | **9.3** Main bearing damaged | **9.3** Inspect the main bearing. Replace if necessary. |
| | **9.4** Rod bearing damaged | **9.4** Inspect the rod bearing. Replace if necessary. |

# Engine Noise (continued)

| Symptom | Cause | Action |
|---|---|---|
| **10. Engine noise in the crankshaft area, throughout the engine, timed to engine speed** | **10.0** Loss of oil pressure | **10.0** Check the crankcase oil level. If low, fill the crankcase and determine the cause of the oil loss.<br>Check for leaks.<br>Check the oil pressure gauge operation.<br>Check the oil pump operation. |
| | **10.1** Main bearings damaged | **10.1** Inspect the main bearing. Replace if necessary. |
| | **10.2** Rod bearings damaged | **10.2** Inspect the rod bearing. Replace if necessary. |
| **11. Engine spark knock** | **11.0** Advanced timing | **11.0** Replace the ECM. |
| | **11.1** Low octane fuel | **11.1** Drain the fuel tank and refill with the appropriate fuel. |
| | **11.2** Engine running hot | **11.2** Check cooling water supply or coolant level. |
| | **11.3** Carbon deposits in the engine | **11.3** Inspect the internal engine components for carbon buildup. Clean or replace. |
| **12. Hissing** | **12.0** Vacuum leak | **12.0** Locate leak and repair. |
| | **12.1** Leaking exhaust (manifolds or pipes) | **12.1** Inspect the exhaust manifolds and elbows for cracks or porosity. Replace the gaskets. |
| | **12.2** Loose cylinder heads | **12.2** Ensure that the cylinder head bolts are properly torqued. Replace the bolts if necessary. |
| | **12.3** Blown head gasket | **12.3** Determine the cause of blown gasket and replace the gasket. |

# Engine Noise (continued)

| Symptom | Cause | Action |
|---|---|---|
| **13. Throttle Body Whistle** | **13.0** Vacuum leak | **13.0** Test and repair leaks. |
| | **13.1** Dry or tight bearing in an accessory | **13.1** Locate the bearing and lubricate or replace. |
| | **13.2** IAC muffler misaligned or missing. | **13.2** Install new muffler or realign. |
| **14. Sparks jumping** | **14.0** Leaking high tension lead | **14.0** Replace the high tension lead. |
| | **14.1** Cracked coil tower | **14.1** Replace the ignition coil. |
| | **14.2** Cracked distributor cap | **14.2** Replace the distributor cap. |
| **15. Squeaks or squeals** | **15.0** Drive belt slipping | **15.0** Replace the drive belt. |
| | **15.1** Dry or tight bearing in an accessory | **15.1** Locate the bearing and lubricate or replace. |
| | **15.2** Parts rubbing together | **15.2** Locate the parts and correct the cause. |
| **16. Rattling in the exhaust pipe area** | **16.0** Exhaust shutters | **16.0** Inspect the exhaust shutters for damage. Replace if necessary. |

# Oil Pressure

| Symptom | Cause | Action |
|---|---|---|
| **1. Loss of engine rpm, oil pressure gauge fluctuation, drop in oil pressure, and hydraulic valve lifter noise at high rpm** | **1.0** Oil level in the crankcase above the FULL mark | **1.0** Drain excess oil. |
| **2. Low oil pressure; oil pressure gauge fluctuation; internal engine noise and/or damage** | **2.0** Oil level in the crankcase below the ADD mark | **2.0** Add oil to the correct level. Determine if engine noise is still present and if so, diagnose internal engine damage. |
| **3. Change in oil pressure** | **3.0** This may be a normal condition. Oil pressure may be high in the cooler times of the day and when the engine is not up to operating temperature. As the air temperature warms up and the engine is operating at normal temperature, it is normal for oil pressure to drop. | **3.0** Check oil level. If oil level is accurate and oil pump appears to be working, no further action is necessary. |
| **4. Low engine oil pressure at idle** | **4.0** With modern engines and engine oils, low oil pressure readings at idle do not necessarily mean there is a problem. If valve lifters do not clatter (at idle), there is a sufficient volume of oil to lubricate all internal moving parts properly. The reason for the drop in oil pressure is that engine heat causes an expansion of the internal tolerances in the engine and the oil will thin out somewhat from heat. | **4.0** Check oil level. Add if necessary. Listen for engine noise. If no noise is present, no further action is necessary. |

# Oil Pressure (continued)

| Symptom | Cause | Action |
|---|---|---|
| **5. Low engine oil pressure at idle after operating at a high rpm** | **5.0** With modern engines and engine oils, low oil pressure readings at idle do not necessarily mean there is a problem. If valve lifters do not clatter (at idle), there is a sufficient volume of oil to lubricate all internal moving parts properly. The reason for the drop in oil pressure is that engine heat causes an expansion of the internal tolerances in the engine and the oil will thin out somewhat from heat. | **5.0** Check oil level. Add if necessary. Listen for engine noise. If no noise is present, no further action is necessary. |
| **6. Differences in oil pressure between engines on boats with dual engines** | **6.0** It is not uncommon to see different oil pressure readings between the two engines, as long as both engines fall within specifications. Differences in oil pressure can be attributed to differences in engine tolerances, gauges, wiring, senders or other differences. | **6.0** Check oil level. Add if necessary. Listen for engine noise. If no noise is present, no further action is necessary. |
| **7. Differences in oil pressure between stations on boats with dual stations** | **7.0** It is not uncommon to see different oil pressure readings between the two stations, as long as both engines fall within specifications. Differences in oil pressure can be attributed to differences in engine tolerances, gauges, wiring, senders or other differences. | **7.0** Check oil level. Add if necessary. Listen for engine noise. If no noise is present, no further action is necessary. |

# Oil Pressure (continued)

| Symptom | Cause | Action |
|---|---|---|
| **8. Low oil pressure** | **8.0** Low oil level in crankcase | **8.0** Check the oil level with the dipstick. Add oil as necessary. |
| | **8.1** Defective oil pressure gauge and/or sender | **8.1** Verify with an automotive test gauge. |
| | **8.2** Thin or diluted oil | **8.2** Change the oil. |
| | **8.3** Faulty oil pump | **8.3** Ensure that the relief valve opens and closes properly. |
| | | Check the pickup tube for restrictions. |
| | | Rebuild or replace the oil pump. |
| | **8.4** Internal or external oil leak | **8.4** Check for oil passage plugs leaking. |
| | | Check the cylinder block for cracks. |
| | **8.5** Excessive bearing clearance | **8.5** Inspect bearings and replace if necessary. |
| **9. High oil pressure** | **9.0** Oil too thick | **9.0** Change the oil. |
| | **9.1** Defective oil pressure gauge and/or sender | **9.1** Verify with an automotive test gauge. |
| | **9.2** Clogged or restricted oil passage | **9.2** Clean all oil passages. |
| | **9.3** Oil pump relief valve stuck closed | **9.3** Repair or replace oil pump. |

# Excessive Oil Consumption

| Symptom | Cause | Action |
|---|---|---|
| **1. Excessive oil consumption** | **1.0** Oil leaks | **1.0** Clean the bilge, place white paper on the floor of the bilge and run the engine to locate oil leaks. |
| | **1.1** Oil too thin | **1.1** Change the oil. |
| | **1.2** Oil level too high | **1.2** Drain the oil and verify the cause of the excessive oil. Change the oil and recheck periodically. |
| | **1.3** Drain holes in cylinder head plugged causing oil to flood the valves | **1.3** Clean the drain holes. |
| | **1.4** Defective valve seals | **1.4** Replace the valve seals. |
| | **1.5** Intake manifold gasket leaking | **1.5** Replace the intake manifold gasket. |
| | **1.6** Worn valve stems or valve guides | **1.6** Replace the valves or valve guides. |
| | **1.7** Defective oil cooler | **1.7** Replace the oil cooler |
| | **1.8** Defective piston rings | **1.8** Replace the piston rings |
| | **1.9** Excessive bearing clearance | **1.9** Replace the bearings |

***NOTE:*** *ENGINE CRANKCASE OIL MUST BE CHECKED AT INTERVALS SPECIFIED IN the MAINTENANCE SCHEDULES in SECTION 1B. It is normal for an engine to use a certain amount of oil in the process of lubricating and cooling the engine. The amount of oil consumption is greatly dependent upon engine speed, with consumption being highest at wide open throttle and decreasing substantially as the engine speed is reduced.*

# Water In The Engine

## Important Information

**IMPORTANT: First determine the location of the water in the engine. This information can be of great help when trying to determine where the water came from and how it got into the engine. The three most common problems are: water on top of the pistons, water in the crankcase oil and when both of those conditions occur simultaneously.**

1. After locating the water, remove all the water from the engine by removing all the spark plugs and cranking the engine over to pump out the cylinders.
2. Change the oil and the filter.
3. Start the engine and see if the problem can be duplicated. If the problem can be duplicated, a mechanical problem exists. If the problem cannot be duplicated, the problem is either an operator error or a problem that exists only under certain environmental conditions.

If the water is contained to the cylinders only, it is usually entering through the intake system, the exhaust system or the head gasket.

If the water is contained to the crankcase only, it is usually caused by a cracked or porous block, a flooded bilge or condensation.

If the water is located in both the cylinders and the crankcase, it is usually caused by water in the cylinders getting past the rings and valves or complete submersion.

Checking for rust in the intake manifold or the exhaust manifolds is a good idea. Rust is a clue that the water entered these areas.

# Water In Engine (continued)

| Symptom | Cause | Action |
|---|---|---|
| **1. Water on top of the pistons** | **1.0** The operator shut the engine off at a high rpm | **1.0** Read and follow the procedures in the Operation Guide. |
| | **1.1** Engine diesels or tries to run backwards | **1.1** Adjust the throttle cable.<br>Ensure engine idles properly. |
| | **1.2** Rain water dripping into the flame arrestor | **1.2** Replace the engine cover. |
| | **1.3** Spark plug misfiring | **1.3** Inspect and service the spark plugs.<br>Replace if necessary. |
| | **1.4** Backwash through the exhaust system | **1.4** Repair the exhaust system. |
| | **1.5** Improper engine or exhaust hose installation | **1.5** Check the engine installation specifications. |
| | **1.6** Cracked exhaust manifold | **1.6** Replace the exhaust manifold. |
| | **1.7** Improper manifold to elbow gasket installation | **1.7** Replace the manifold to elbow gasket. |
| | **1.8** Loose cylinder head bolts | **1.8** Tighten the cylinder head bolts. |
| | **1.9** Blown cylinder head gasket | **1.9** Determine the cause of blown gasket and replace the gasket. |
| | **1.10** Cracked valve seat | **1.10** Replace the valves. |
| | **1.11** Porous or cracked casting | **1.11** Inspect and repair or replace as necessary. |
| **2. Water in crankcase oil** | **2.0** Water in boat bilge | **2.0** Drain the water from the bilge. |
| | **2.1** Water seeping past the piston rings or valves | **2.1** Replace the piston rings or the valves. |
| | **2.2** Engine operating cold | **2.2** Replace the thermostat. |
| | **2.3** Intake manifold leaking near a water passage | **2.3** Inspect the intake manifold for cracks. Check the gaskets. |
| | **2.4** Cracked or porous casting | **2.4** Check the cylinder head, the cylinder block and the intake manifold for cracks or porosity. |

# Engine Overheats (Mechanical)

**IMPORTANT: The first step is to verify if the engine is actually overheating or if the temperature gauge or sender is faulty.**

| Symptom | Cause | Action |
|---|---|---|
| **1. Engine overheats (mechanical)** | **1.0** Engine rpm below specifications at WOT (engine laboring) | **1.0** Replace the propeller.<br>Clean the boat bottom.<br>Check the false bottom for water. |
| | **1.1** Incorrect rotor location | **1.1** Reset rotor location. |
| | **1.2** Spark plug wires crossed (wrong firing order) | **1.2** Install the spark plug wires correctly. |
| | **1.3** Lean fuel mixture | **1.3** Drain the fuel tank and refill with the appropriate fuel. |
| | **1.4** Wrong heat range spark plugs | **1.4** Replace the spark plugs. |
| | **1.5** Exhaust restriction | **1.5** Inspect the exhaust system and repair. |
| | **1.6** Valve timing off | **1.6** Refer to the Engine Mechanical section for valve adjustment. |
| | **1.7** Blown head gaskets | **1.7** If the engine overheats above 3000 rpm, replace the head gasket. On seawater cooled engines, install a clear plastic hose between the thermostat housing and the exhaust manifolds. If air bubbles are present at a higher rpm, replace the head gasket. |
| | **1.8** Insufficient lubrication to the moving parts of the engine | **1.8** Check the oil level. Fill if necessary. Check the oil flow through the oil passages. Clean as necessary. |

# Engine Overheats (Mechanical) (continued)

| Symptom | Cause | Action |
|---|---|---|
| **2. Engine overheats (cooling system)** | **2.0** Loose or faulty drive belt | **2.0** Replace the serpentine drive belt. |
| | **2.1** Seawater shut off valve partially or fully closed (if equipped) | **2.1** Open the seawater shutoff valve. |
| | **2.2** Clogged or improperly installed sea strainer | **2.2** Clean the sea strainer.<br>Reinstall the sea strainer. |
| | **2.3** Loose hose connections between the seawater pickup and seawater pump inlet | **2.3** Tighten the all hose clamps. |
| | **2.4** Seawater inlet hose kinked or collapsed | **2.4** Visually inspect the seawater inlet hose and shorten or replace if necessary. |
| | **2.5** Seawater pickup clogged | **2.5** Clean the seawater pickup. |
| | **2.6** Obstruction on the boat bottom causing water turbulence | **2.6** Clean the boat bottom. |
| | **2.7** Defective thermostat | **2.7** Replace the thermostat. |
| | **2.8** Exhaust elbow water outlet holes plugged | **2.8** Clean the water outlet holes. |
| | **2.9** Insufficient seawater pump operation | **2.9** Refer to SECTION 6. |
| | **2.10** Obstruction in cooling system such as casting flash, sand, rust and salt. | **2.10** Flush the cooling system. |
| | **2.11** Engine circulating pump defective | **2.11** Replace the water circulating pump. |
| | **2.12** Low coolant level | **2.12** Fill the coolant reservoir. |
| | **2.13** Antifreeze not mixed properly | **2.13** Drain and replace the coolant. |
| | **2.14** Heat exchanger cores plugged | **2.14** Clean the heat exchanger. |
| | **2.15** Water hoses reversed at the water distribution block | **2.15** Install the hoses properly. |
| | **2.16** Worn or damaged seawater pump impeller | **2.16** Replace the seawater pump impeller. |

# Engine Overheats (Mechanical) (continued)

| Symptom | Cause | Action |
|---|---|---|
| **3. Insufficient water flow from the belt driven seawater pickup pump** | **3.0** Drive belt loose, worn or broken | **3.0** Replace the serpentine drive belt |
| | **3.1** Seawater shutoff valve partially or fully closed | **3.1** Open the seawater shutoff valve. |
| | **3.2** Clogged or improperly installed sea strainer | **3.2** Clean the sea strainer.<br>Reinstall the sea strainer. |
| | **3.3** Lose hose connections between seawater pickup and seawater pump inlet | **3.3** Tighten all hose clamps. |
| | **3.4** Seawater inlet hose kinked or plugged | **3.4** Visually inspect the seawater inlet hose and shorten or replace if necessary. |
| | **3.5** Seawater pickup plugged | **3.5** Clean the seawater pickup. |
| | **3.6** Obstruction on the boat bottom causing water turbulence | **3.6** Clean the boat bottom. |
| | **3.7** Faulty seawater pump | **3.7** Replace the seawater pump. |
| | **3.8** Worn or damaged seawater pump impeller | **3.8** Replace the seawater pump impeller. |

# Power Steering

| Symptom | Cause | Action |
|---|---|---|
| **1. Poor, erratic or no assist** | **1.0** Drive belt worn or broken | **1.0** Replace the drive belt. |
| | **1.1** Fluid level low | **1.1** Fill the system. |
| | **1.2** Air in the system | **1.2** Bleed the lines. |
| | **1.3** Leaking hoses | **1.3** Bleed the lines. |
| | **1.4** Steering cables and/or steering helm | **1.4** Clean the rust or the debris from the cable and the helm. |
| | | Remove and reinstall the cable. |
| | | Check the cable lubrication. |
| | **1.5** Binding in sterndrive unit | **1.5** Inspect cause and repair. |
| | **1.6** Restriction in hydraulic hoses causing loss of pressure | **1.6** Inspect the hydraulic hoses for kinks. Bleed the system and refill. |
| | **1.7** Control valve not properly positioned or balanced. | **1.7** Position control valve properly. |
| | **1.8** Mounting bracket adjusting screw loose or mounting tube is loose | **1.8** Check the mounting nut for tightness. |
| | **1.9** Faulty pump causing flow control valve to stick | **1.9** Repair or replace the pump. |
| | **1.10** Worn piston ring or scored housing bore in cylinder causing loss of pressure | **1.10** Inspect the piston rings and the cylinder bore. Replace the piston rings or repair the bore as necessary. |
| | **1.11** Leaking valve body or loose fitting spool | **1.11** Tighten the fitting spool. Repair or replace the valve body. |

# Power Steering (continued)

| Symptom | Cause | Action |
|---|---|---|
| **2. Noisy pump** | **2.0** Drive belt loose | **2.0** Replace the serpentine belt. |
| | **2.1** Low fluid level | **2.1** Fill the power steering pump reservoir and bleed the lines. |
| | **2.2** Air in fluid | **2.2** Drain the power steering system, fill the power steering pump reservoir and bleed the lines. |
| | **2.3** Faulty pump | **2.3** Replace the pump. |
| | **2.4** Restricted fluid passages | **2.4** Inspect and clean the fluid passages. |
| | **2.5** Stop nut adjusted improperly | **2.5** Adjust the stop nut. |
| | **2.6** Steering cables installed that do not meet BIA standards | **2.6** Install the appropriate cables. |
| **3. Fluid leaks** | **3.0** Loose hose connections | **3.0** Tighten all hose clamps. Bleed the system. |
| | **3.1** Damaged hose | **3.1** Inspect and replace the damaged hose. |
| | **3.2** Oil leaking from the top of the pump | **3.2** Drain excess oil. Bleed the system. |
| | **3.3** Cylinder piston rod seal | **3.3** Replace internal engine components as necessary. |
| | **3.4** Faulty seals in valve | **3.4** Replace the seals in the valve. |
| | **3.5** Faulty seals or O-rings in the pump | **3.5** Replace the seals or the O-rings in the pump. |
| | **3.6** Cracked or porous metal parts | **3.6** Inspect all power steering components. Place white cloth under the engine to determine the location of the leak. |

# Drain System Will Not Drain Or Drains Slowly

| Symptom | Cause | Action |
|---|---|---|
| **1. Drain system will not drain or drains slowly** | **1.0** Drain system not open | **1.0** Verify draining procedure. |
| | **1.1** Cooling system or drain holes plugged with debris | **1.1** Inspect drain hole in the water distribution housing for debris. Remove the blue drain plugs and inspect for blockage.<br>Flush the cooling system and drain the engine. |
| | **1.2** Air actuator malfunction | **1.2** Inspect the air lines from the air manifold and the drain actuator for kinks, damage and leaks.<br>Inspect the air manifold and the fittings for cracks, leaks,damage or corrosion. |
| | **1.3** Boat sitting on an incline | **1.3** Boat must be at rest and level when draining the engine. |
| | **1.4** Draining the engine while boat is in the water | **1.4** Read Boat in the Water Procedure in the Operation, Maintenance and Warranty Manual. |
| | **1.5** Water in the engine is frozen | **1.5** Thaw engine and inspect for freeze damage. |
| **2. Drain system leaking at the orange drain seal** | **2.0** Drain rod misaligned | **2.0** Realign the drain rod. |
| | **2.1** Drain rod bent | **2.1** Replace the drain rod. |
| | **2.2** Drain rod not closed completely (red visible) | **2.2** Close drain system. |
| | **2.3** Actuator piston not closed | **2.3** Activate pressure relief valve.<br>Inspect and clean the water distribution housing and the sea pump drain actuator. Replace if damaged. |
| **3. Manual drain system leaking while underway** | **3.0** Drain rod misaligned | **3.0** Realign the drain rod. |
| | **3.1** Drain rod bent | **3.1** Replace the drain rod. |
| | **3.1** Drain rod scratched, cut or damaged | **3.1** Replace the drain rod. |
| | **3.2** Water distribution housing seal damaged | **3.2** Replace the housing. |
| **4. Water leaking out of the pressure relief valve on the air manifold** | **4.0** Seawater pump seal leaking | **4.0** Replace the drain portion of the seawater pump. |
| | **4.1** Vents on the drain actuator are under the waterline | **4.1** Empty water from bilge. |

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# REMOVAL AND INSTALLATION

## Section 2A - MCM Models

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# Torque Specifications

***NOTE:*** *Securely tighten all fasteners not listed below.*

| Description | Nm | lb-in. | lb-ft |
|---|---|---|---|
| Gear Lube Monitor Fitting | 9 | 80 | |
| Speedometer Pickup Barb Fitting | 1.5 | 13 | |
| Exhaust Pipe or Block-off Plate | 31 | | 23 |
| Power Steering Hydraulic Hose Fittings | 31 | | 23 |
| Power Trim Pump Hose Fittings | 14 | 125 | |
| Propeller Nut Alpha One, Bravo One and Bravo Two[1] | 75 | | 55 |
| Front Propeller Nut Bravo Three | 136 | | 100 |
| Rear Propeller Nut Bravo Three | 81 | | 60 |
| Rear Engine Mounts | 51 | | 38 |
| Steering Cable Coupler Nut | 48 | | 35 |
| Steering System (Pivot Bolts) | 34 | | 25 |
| Sterndrive Unit Fasteners | 68 | | 50 |
| Transom Assembly Fasteners | 31 | | 23 |
| Seawater Pickup Fitting | 5 | 45 | |
| Flame Arrestor Bolts | 12 | | 9 |
| Fuel Inlet Fitting | Finger tight + 1-3/4 to 2-1/4 turns with a wrench. Do NOT overtighten. | | |

[1] Amount specified is MINIMUM.

# Lubricants / Sealants / Adhesives

| Description | Where Used | Part Number |
|---|---|---|
| Engine Coupler Spline Grease | Coupler Splines | 92-802869A1 |
| | Drive Unit Pilot | |
| | U-Joint O-rings | |
| | Drive Shaft Splines | |
| 2-4-C Marine Lubricant With Teflon | Anchor Pins | 92-802859A1 |
| | Trim Cylinder Hardware | |
| | O-ring Seals | |
| | Shift Cable End | |
| | Propeller Splines | |
| Special Lubricant 101 | Pivot Bolts | 92-802865A1 |
| | Power Steering Bushings | |
| | Clevis Pin | |
| | Steering Cable End | |
| | Propeller Splines | |
| Dexron III - Automatic Transmission Fluid | Power Steering Pump | Obtain Locally |
| Power Trim and Steering Fluid | Power Steering Pump | 92-802880A1 |
| | Power Trim Pump | |
| Liquid Neoprene | Battery Terminals | 92-25711-3 |
| | MerCathode Connections | |
| Loctite 592 PST | Speedometer Barb Fitting | Obtain Locally |
| | Fuel Inlet Fitting | |
| | Seawater Inlet Hose Fitting Threads | |
| | Seawater Inlet Plastic Plug Threads | |

# Lubricants / Sealants / Adhesives (continued)

| Description | Where Used | Part Number |
|---|---|---|
| Loctite 271 | Seawater Inlet Nut | 92-809819 |
| Engine Oil | Power Trim Pump | Obtain Locally |
| | Shift Cable Pivot Points | |
| SAE 10W40 Engine Oil | Power Trim Pump | Obtain Locally |
| Marine Caulking | Seawater Inlet Mounting Surfaces | Obtain Locally |
| Power Tune | Exhaust Tubes | 92-802878-57 |
| High Performance Gear Lube | Sterndrive Unit | 92-802854A1 |
| Silicone Sealant Or Equivalent | Screw Shaft | Obtain Locally |

# Special Tools

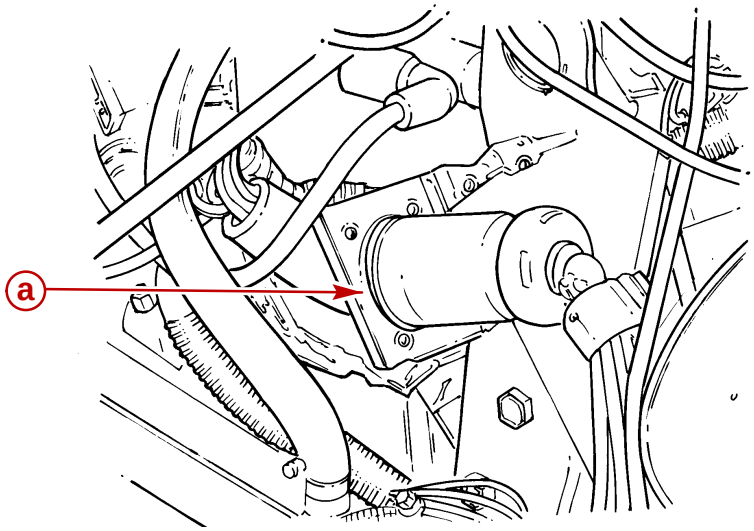
| Description | Part Number |
|---|---|
| Transom Drilling Fixture | 91-43693A2 |
| Engine Alignment Tool | 91-805475A1 |
| Shift Cable Adjustment Tool | 91-12427 |
| Engine Mount Drilling Fixture | 91-806794A1 |
| Tapered Insert Tool | 91-43579 |
| Shift Shaft Slide Stabilizer Tool | 91-809815A1 |

# Removal

**⚠ WARNING**

**Avoid injury or death and power package damage from an electrical shock, fire or explosion. Always disconnect both battery cables from the battery before servicing the power package.**

1. Disconnect the battery cables from the battery.
2. Remove the engine cover.
3. Loosen the clamp and remove the instrument wiring harness plug from the engine wiring harness receptacle.

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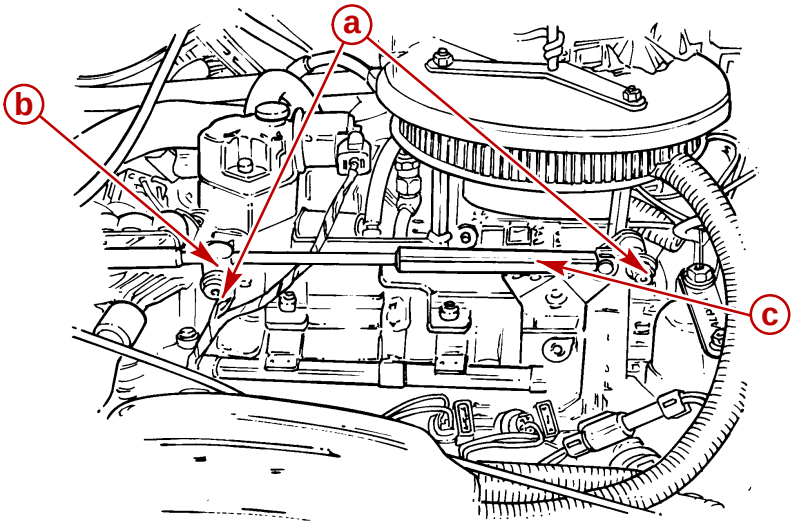
**a -** Engine Wiring Harness Receptacle

**⚠ WARNING**

**Be careful when working on the fuel system. Gasoline is extremely flammable and highly explosive under certain conditions. Do not smoke or allow spark or open flame in area. Wipe up any spilled fuel immediately.**

4. Loosen the hose clamp retaining fuel line to the fuel inlet.
5. Close the fuel shut off valve, if equipped.
6. Disconnect and plug the fuel line to prevent fuel in the line from leaking into the bilge.

7. Disconnect the throttle cable and retain the fasteners.

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**a** - Flat Washer And Locknut
**b** - Cable Barrel
**c** - End Guide

8. Disconnect the shift cable from the shift plate and retain the fasteners.
9. DIsconnect the power steering hoses.
10. Disconnect the seawater inlet hose from the transom.

11. Loosen the hose clamps at the bullhorn.
12. Remove the gear lube monitor and the hose and place out of the way.
13. Disconnect any grounding wires and accessories that are connected to the engine.

**⚠ CAUTION**

**Engine MUST be lifted with a lifting arm or damage to the engine components will occur. DO NOT allow the lifting sling to hook or compress the engine components or damage will occur.**

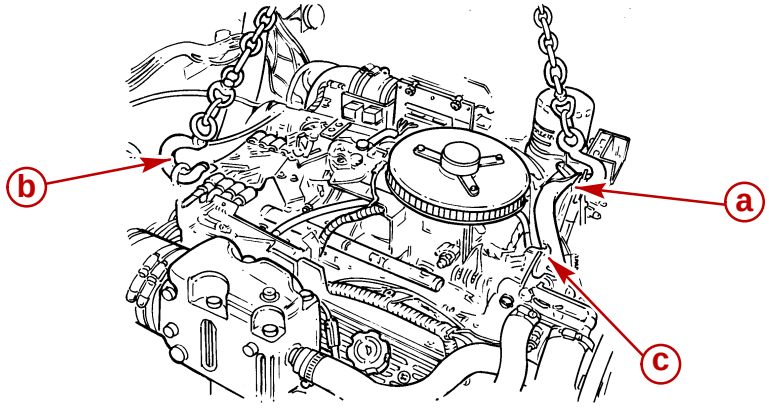
**⚠ CAUTION**

**Engine compartment size may require the removal of additional components.**

14. Support the engine with a suitable sling through the lifting eyes on the engine.

**⚠ CAUTION**

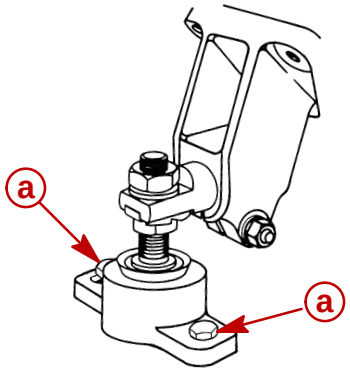
**Center lifting eye on top of thermostat housing is used for engine alignment only. Do not use to lift entire engine.**




77912

**a** - Front Lifting Eye
**b** - Rear Lifting Eye
**c** - Center Lifting Eye

15. Remove the rear engine mounting bolts.
16. Remove the front lag bolts. Retain the fasteners.




72638

**a -** Lag Bolt (With Washers)

17. Carefully remove the engine.

# Engine Installation

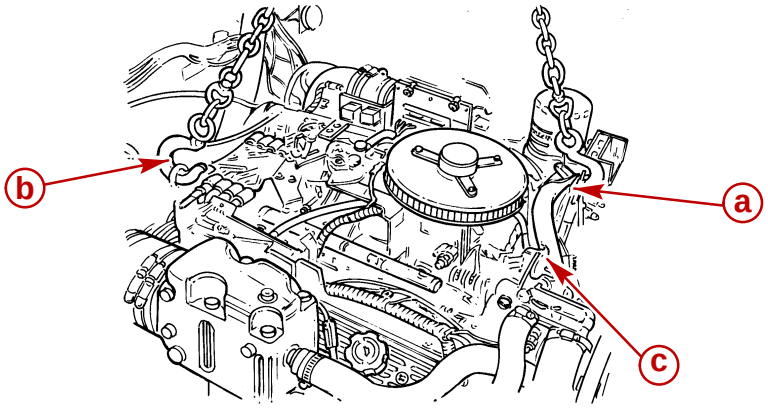
***NOTE:*** *An engine mount drilling fixture (91-806794A1) can be used to align and adjust the engine mounts. Refer to instructions the with the fixture for proper use.*

1. Attach a suitable sling to the lifting eyes on the engine and adjust so that the engine is level when suspended.

**⚠ CAUTION**

**Center lifting eye on top of the thermostat housing is used for engine alignment only. Do not use to lift the entire engine.**

2. Lift the engine into position in the boat using an overhead hoist.




77912

**a -** Front Lifting Eye
**b -** Rear Lifting Eye
**c -** Center Lifting Eye

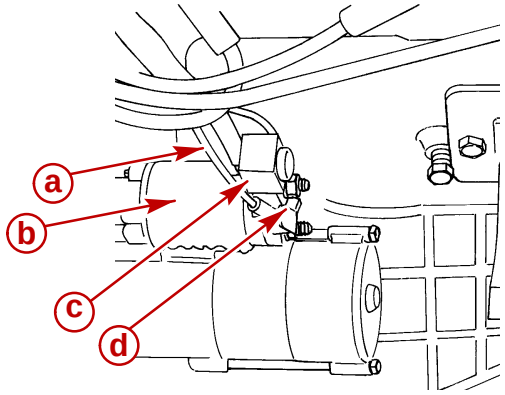
3. Ensure that the grounding stud and starter solenoid terminal are free of paint or any other material that could cause a poor electrical connection.

4. Connect the battery cables to the engine. Apply a thin coat of sealant to the terminals.

| Description | Where Used | Part Number |
|---|---|---|
| Liquid Neoprene | Battery Terminals | 92-25711-3 |

5. Slide the rubber boot over the positive (+) terminal.
6. Drape battery cables over top of engine to prevent interference during installation.

**IMPORTANT: There is a fuse located at the starter solenoid. Do NOT remove this fuse. The positive battery cable must be connected to the same stud as the fuse.**

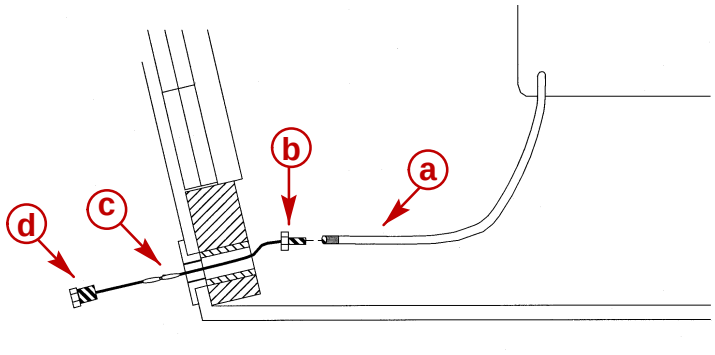



74907

**a -** Positive (+) Battery Cable
**b -** Starter Solenoid
**c -** 90 Amp Fuse - Do NOT Remove
**d -** Rubber Boot Location

7. Push the end of the oil drain hose out of the boat hull through the flange.
8. Pull the oil drain hose out until it is 152 mm (6 in.) from the propeller.
9. Move the alignment clip on the oil drain hose and squeeze to position it on the hose just inside the boat hull against the flange.

10. Connect the bilge drain plug to the oil drain hose plug using the clip.

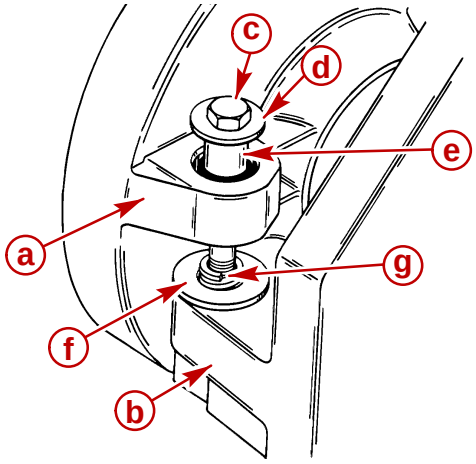



78002

**a** - Oil Drain Hose
**b** - Alignment Clip
**c** - Clip
**d** - Bilge Drain Plug

**IMPORTANT: If the Quick Drain Oil Fitting is within 13 mm (1/2 in.) of the boat bottom, remove the fitting and install the drain plug from the parts bag directly into the oil pan.**

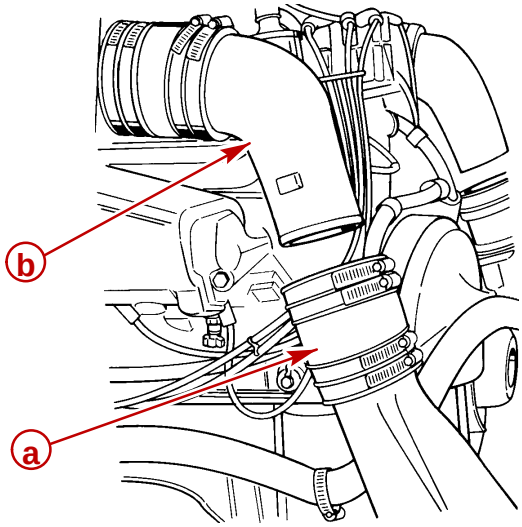
11. Push the oil drain hose through the flange into the boat hull.
12. Install the bilge drain plug in the hull.
13. Align the rear engine mounts with the inner transom plate mounts while simultaneously aligning the exhaust tube with the exhaust pipe bellows.




22032

**a** - Rear Engine Mount
**b** - Inner Transom Plate Mount
**c** - Bolt
**d** - Washer
**e** - Spacer
**f** - Fiber Washer
**g** - Double-Wound Lockwasher

14. Install both the rear engine mounting bolts and the hardware. Torque the bolts and the hardware. Do not relieve the tension on the hoist.




50682

**a -** Exhaust Pipe Bellows
**b -** Exhaust Tube

| Description | Nm | lb-in. | lb-ft |
|---|---|---|---|
| Engine Mounting Bolts and Hardware | 51 | | 38 |

**IMPORTANT: If the Quick Drain Oil Fitting is within 13 mm (1/2 in.) of the boat bottom, remove the fitting and install the drain plug from the parts bag directly into the oil pan.**

15. Ensure that the quick drain oil fitting is more than 13 mm (1/2 in.) above the boat bottom.

**⚠ CAUTION**

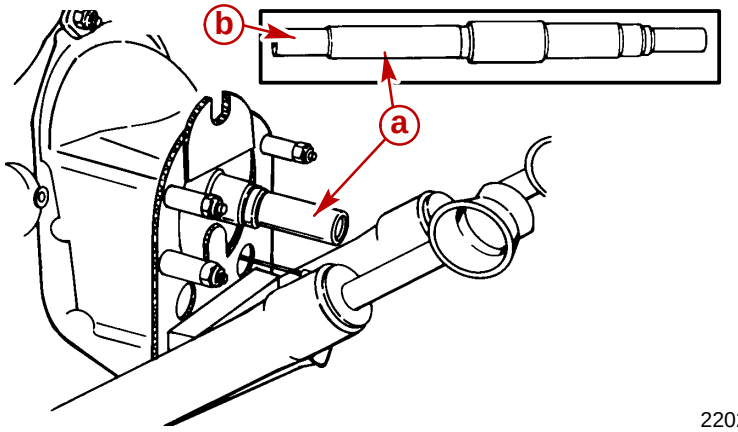
**Do NOT use an alignment tool from a manufacturer other than Quicksilver as it may cause improper alignment and damage to the gimbal bearing or the engine coupler.**

**⚠ CAUTION**

**To avoid damage to the gimbal bearing, the engine coupler or the alignment tool:**

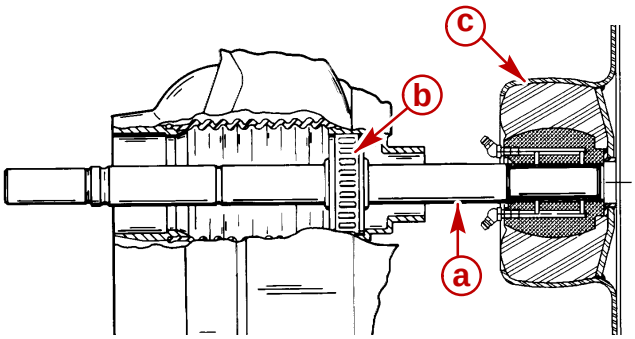
- **Do NOT attempt to force the alignment tool!**
- **Do NOT raise or lower the engine with the alignment tool inserted (or partially inserted) in the gimbal bearing or the engine coupler.**

16. Attempt to insert the solid end of the alignment tool through the gimbal bearing and into the engine coupler splines.
17. If the tool does not fit, remove it and carefully raise or lower the front end of the engine using the center alignment eye and attempt to insert the alignment tool.
18. Repeat Step 17. until the alignment tool installs easily **(SLIDES FREELY WITH TWO FINGERS)** all the way into and out of the engine coupler splines. Do not check by turning.




22029

**a** - Alignment Tool (Use Only Recommended Alignment Tool)
**b** - Insert This End Of Alignment Tool Through Gimbal Housing Assembly




27647

**a** - Alignment Tool
**b** - Gimbal Bearing
**c** - Engine Coupler

**IMPORTANT: Finished boat stringer must position the engine so that a minimum mount adjustment exists after the front mount is adjusted down to the stringer. This allows for future adjustments.**

**IMPORTANT: Turn both front engine mount adjustment nuts an equal amount in the direction required to align the engine.**

19. Adjust the front engine mounts until they rest on the boat stringers.
20. Relieve the hoist tension entirely and fasten both front mounts to the boat stringer using appropriate hardware.
21. Recheck the alignment with the alignment tool. The tool must enter the engine coupler splines freely. If not, readjust the front mounts.
22. When the alignment is correct, tighten the locknut securely. Recheck the alignment.
23. Bend the tab down on the adjusting nut.
24. Remove the alignment tool.
25. Install the sterndrive unit.

# Electrical Connections

## EFI Electrical System Precautions

**⚠ CAUTION**

**Avoid damage to the EFI electrical system components. Refer to the following precautions when working on or around the EFI electrical harness or when adding other electrical accessories:**

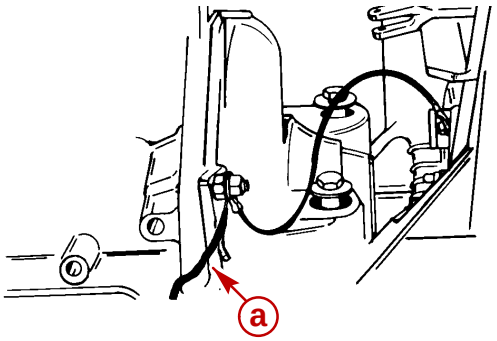
- **Do NOT tap the accessories into the engine harness.**
- **Do NOT puncture wires for testing (Probing).**
- **Do NOT reverse the battery leads.**
- **Do NOT splice wires into the harness.**
- **Do NOT attempt diagnostics without proper, approved Service Tools.**

**IMPORTANT: When routing all wire harnesses and hoses, ensure that they are routed and secured to avoid coming in contact with hot spots on the engine and to avoid contact with moving parts.**

## Installing Continuity Wire

1. Connect the continuity circuit wire from the engine to the transom assembly.

**IMPORTANT: Do not attach any accessory ground (–) wires to the transom plate ground point. Accessory ground wires can only be attached to the ground stud on the engine.**




71651

**a -** Negative (–) Battery Cable

## Instrumentation Connections

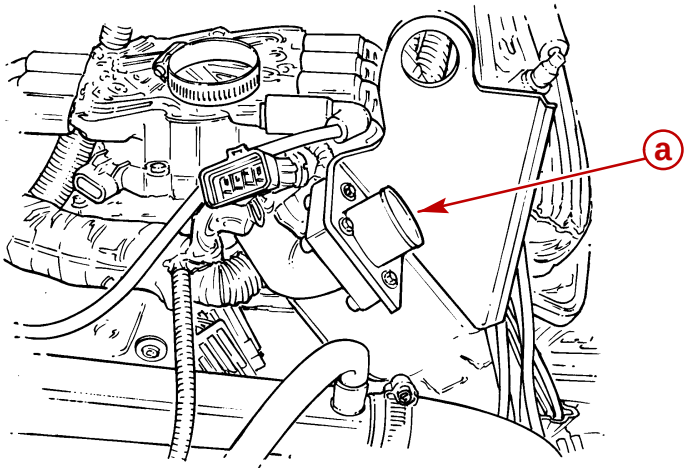
We recommend the use of Quicksilver Instrumentation and Wiring Harnesses which have been specifically designed for compatibility with our engines. Instrumentation wiring extension harnesses are available in several lengths. Refer to *Mercury Precision Parts / Quicksilver Accessories Guide* for selection.

Refer to Instrumentation Wiring Diagrams for specific wiring diagrams.

**⚠ CAUTION**

**If a Quicksilver wiring harness is used and a fused accessory panel is to be installed (40-amp current draw maximum), connect it as shown in the wiring diagrams. Do not connect the accessory panel at any other location as the wires in the wiring harness may not be of sufficient size to handle the current load.**

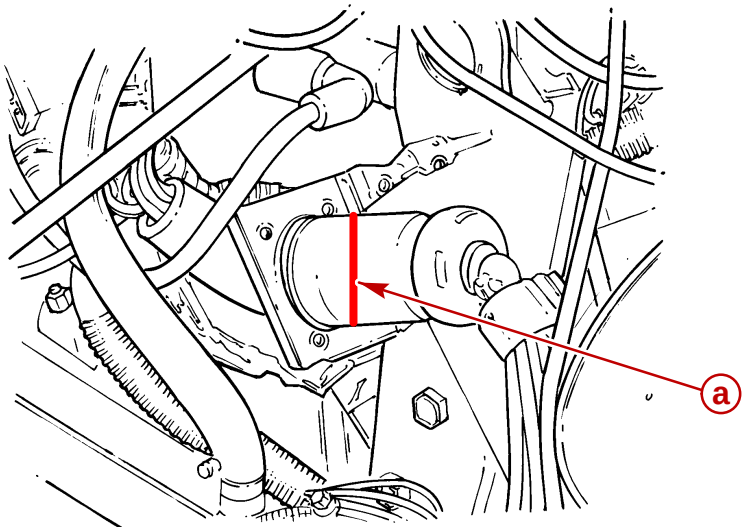
1. Connect the instrumentation wiring harness to the engine harness plug at the location shown.




78254

**a -** Instrumentation Wiring Harness

2. Place the hose clamp on the location shown.

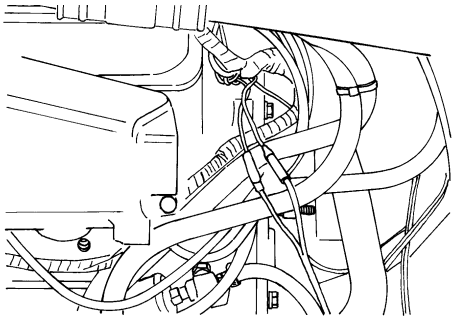


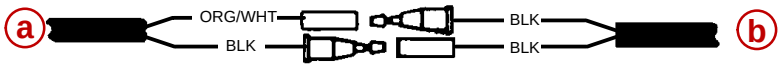

78031

**a -** Hose Clamp Location

## Trim Position Sender Connections

1. Connect the trim position sender wires from the transom assembly to the engine harness. Use the ORG/GRY wire for analog gauges and the ORG/WHT for digital gauges.





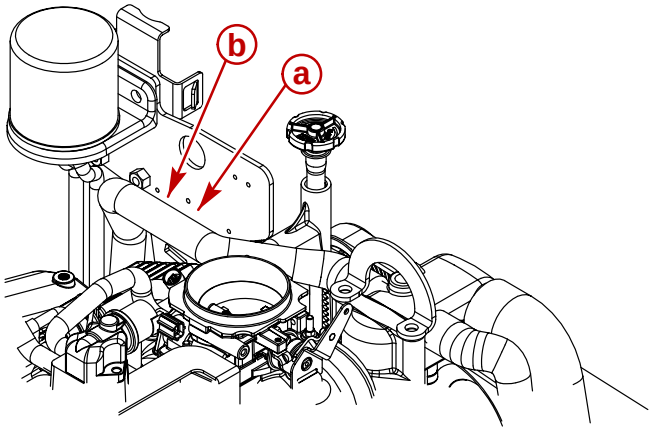

74029

**a -** Engine Harness Bullet Connector
**b -** Transom Assembly Bullet Connectors

# MerCathode Connections

The MerCathode controller assembly is located on the back of the front lifting eye. The upper hose must be disconnected from the thermostat housing for access.

1. Move or remove the thermostat housing hose to gain access to the MerCathode controller assembly.



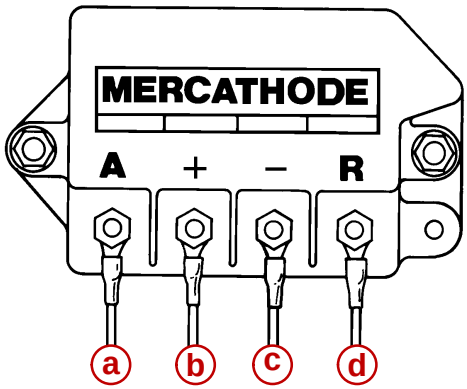

check

78129

**a -** MerCathode Controller Location
**b -** Thermostat Housing Hose

2. Connect the wires to the MerCathode controller assembly as shown. Apply a thin coat of sealant to all wire connections.

**IMPORTANT: The opposite end of the red/purple wire must be connected directly to the battery positive (+) terminal. Do NOT connect it to a switched positive (+) circuit. The MerCathode system must function continuously for proper corrosion protection.**




22232

**a -** ORANGE Wire - From Electrode on Transom Assembly
**b -** RED/PURPLE Wire - Connect (Other End) To Positive (+) Battery Terminal
**c -** BLACK Wire - From Engine Harness
**d -** BROWN Wire - From Electrode on Transom Assembly

| Description | Where Used | Part Number |
|---|---|---|
| Liquid Neoprene | MerCathode Connections | 92-25711-3 |

## Audio Warning Alarm Connections

1. Connect the PURPLE wire from the alarm to any PURPLE wire terminal on the instrument gauge or the ignition switch. Tighten the connection securely.
2. Connect the TAN/BLUE wire from the alarm to the TAN/ BLUE wire from the instrument harness.

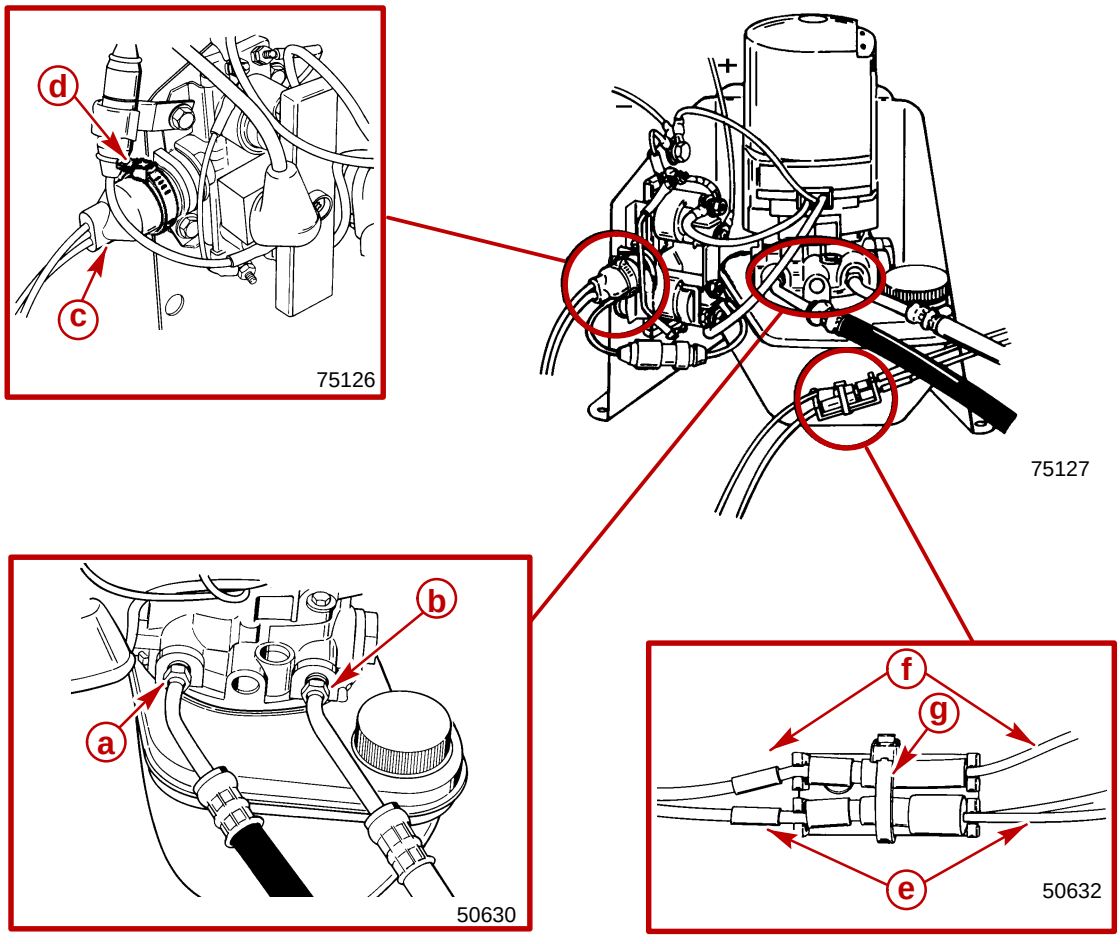
## Power Trim Pump Connections

**IMPORTANT: Make the hydraulic connections as quickly as possible to prevent oil from leaking out of the system. Be careful not to cross-thread or overtighten the hose fittings.**

1. Connect the hydraulic hoses to the trim pump. Torque the fittings.

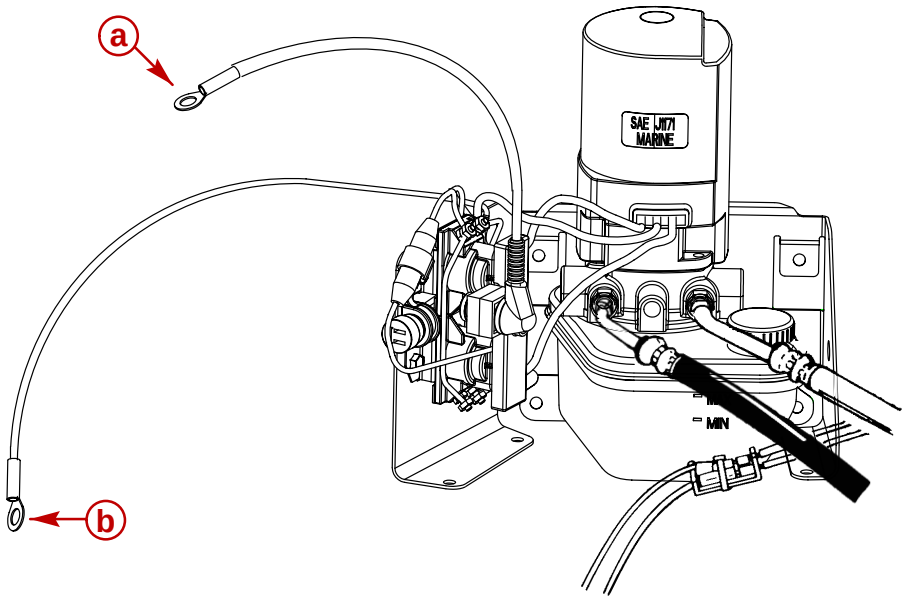
| Description | Nm | lb-in. | lb-ft |
|---|---|---|---|
| Hydraulic Hose Fittings | 14 | 125 | |

2. Connect the power trim pump control harness to the trim pump.
3. Connect the trim limit switch wires and secure with the wire retainer and tie strap.




**a** - Black Hose Fitting (UP Circuit)
**b** - Gray Hose Fitting (DOWN Circuit)
**c** - Control Harness
**d** - Tie Strap
**e** - Trim Limit Switch Wire (With Blue Sleeve) To BLUE/WHITE Harness Wire
**f** - Trim Limit Switch Wire (With Purple Sleeve) To PURPLE/WHITE Harness Wire
**g** - Wire Retainer And Tie Strap

4. Connect the power trim pump wires to the battery.




76631

**a** - Positive Battery Lead
**b** - Negative Battery Lead

# Fluid Connections

## Fuel

**IMPORTANT: The following information is provided to ensure proper installation of brass fittings or plugs installed into fuel pump or fuel filter base:**

- **Use #592 Loctite Pipe Sealant with Teflon on threads of fuel inlet fittings or plugs. DO NOT USE TEFLON TAPE.**
- **Fuel inlet fittings or plugs should first be threaded into fuel pump or fuel filter base until finger tight.**
- **Fuel inlet fittings or plugs should then be tightened an additional 1-3/4 to 2-1/4 turns using a wrench. DO NOT OVERTIGHTEN.**
- **To prevent over-tightening when installing a fuel line, the brass fittings should be held with a suitable wrench as fuel inlet fittings are tightened securely.**

**⚠ WARNING**

**Boating standards (NMMA, ABYC and others) and Coast Guard regulations must be adhered to when installing fuel delivery system.**

**⚠ WARNING**

**Avoid gasoline fire or explosion. Improper installation of brass fittings or plugs into fuel pump or fuel filter base can crack casting and/or cause a fuel leak.**

1. Connect the fuel inlet line to the water separating fuel filter.
2. Open the fuel shut off valve, if equipped.

# Gear Lube Monitor Hose

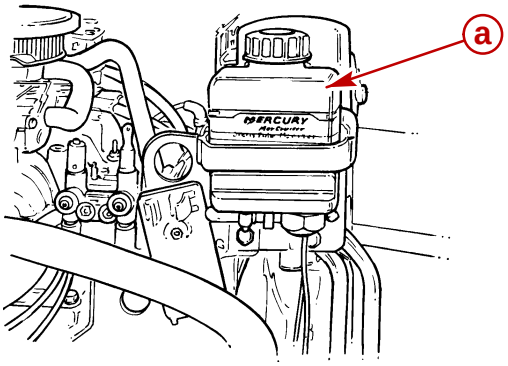
**IMPORTANT: Avoid using excessive hose when routing it to the gear lube monitor. The hose should be routed directly to the oil reservoir in as straight a line as possible to avoid low spots (traps) in the system.**

**⚠ CAUTION**

**Ensure that the hose is not kinked when connecting in the following step. If the hose is kinked, the gear lube monitor will not function properly and damage to the drive unit could occur.**

1. Route the hose to the gear lube monitor and cut off the excess hose. Connect the hose and secure with a hose clamp.

**IMPORTANT: The hose must not come in contact with the steering system components, the engine coupler, the U-joint shaft or the drive shaft.**




77813

**a -** Gear Lube Monitor

# Power Steering Hoses

**⚠ CAUTION**

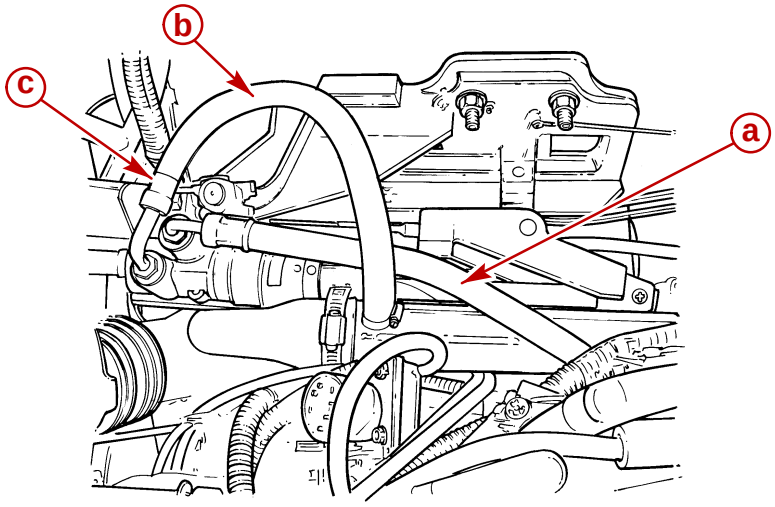
**Route the hoses exactly as shown below. This will help avoid stress on the hose fittings and will help avoid kinks in the hose.**

**IMPORTANT: Make the hydraulic connections as quickly as possible to prevent fluid leakage.**

**IMPORTANT: Be careful not to cross-thread or overtighten the fittings.**

1. Route the hoses. Secure the hoses to avoid contact with moving components.
2. Connect the power steering hoses to the control valve. Torque both fittings.

| Description | Nm | lb-in. | lb-ft |
|---|---|---|---|
| Power Steering Hoses | 31 | | 23 |




77845

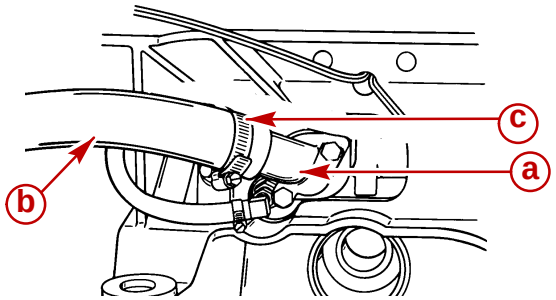
**a** - Rear Fitting (Pressure Hose)
**b** - Front Fitting (Return Hose)
**c** - Control Valve

3. Use extra hose clips to secure the hose to the transom.

***NOTE:*** *Power steering fluid can be added at this point, if desired.*

## Bravo Models and Alpha Seawater Cooled Models Using Sterndrive Water Pickups

1. Connect water hose to water inlet fitting.
2. Secure with hose clamp.




72040

**a** - Water Inlet Fitting
**b** - Hose
**c** - Hose Clamp

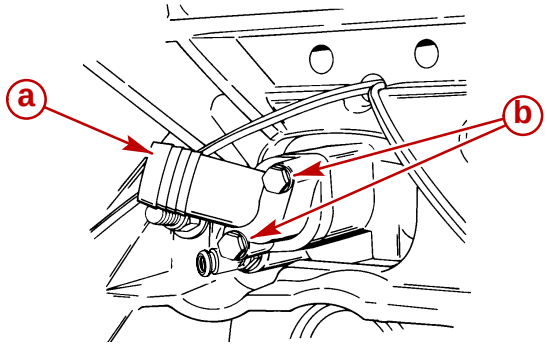
## Alpha or Bravo Models Using Alternative Water Pickups

A water inlet block-off kit must be used if the sterndrive unit water pickup will not be used to supply water to the engine. When installing the block-off plate, it is necessary to cut the water hose that is located between the bell housing and the gimbal housing. This allows water to continue to circulate through the sterndrive unit for cooling.

**⚠ CAUTION**

**Avoid overheating the sterndrive unit. The seawater inlet holes must be allowed to flow water without being obstructed or overheating damage to sterndrive may result. Do not dead-end seawater hose from bell housing. Cut hose as recommended in procedures.**

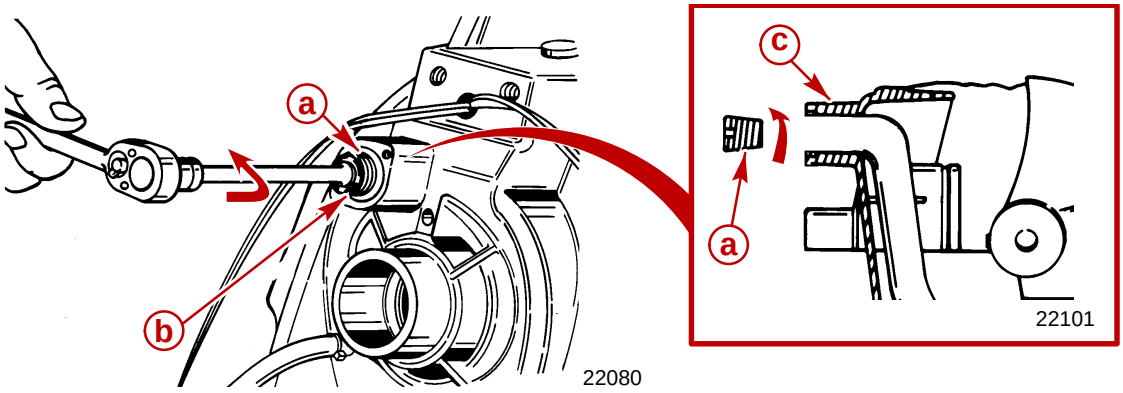
1. Remove the existing water fitting and gasket. Discard the screws and lockwashers.




50663

**a** - Water Fitting
**b** - Screws And Lockwashers

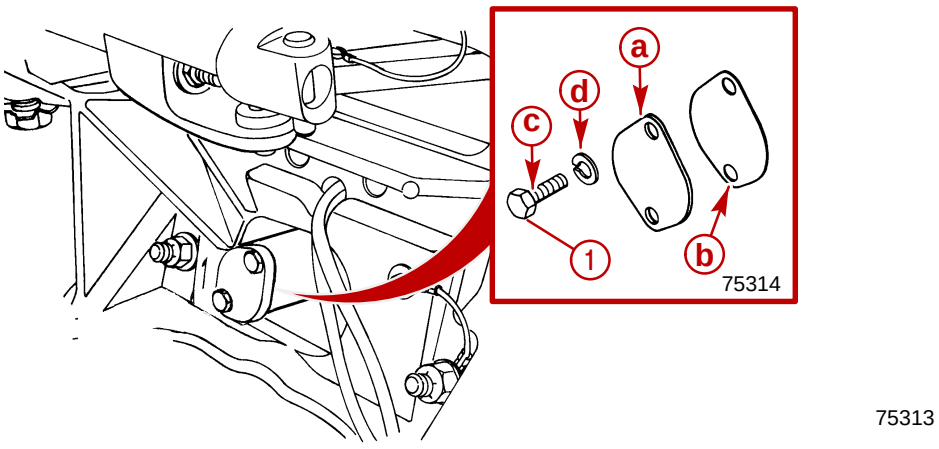
2. Remove the tapered insert in the gimbal housing using the tapered insert tool. Discard the insert.




**a** - Tapered Insert
**b** - Tapered Insert Tool
**c** - Gimbal Housing Cross-Sectional View

| Description | Part Number |
|---|---|
| Tapered Insert Tool | 91-43579 |

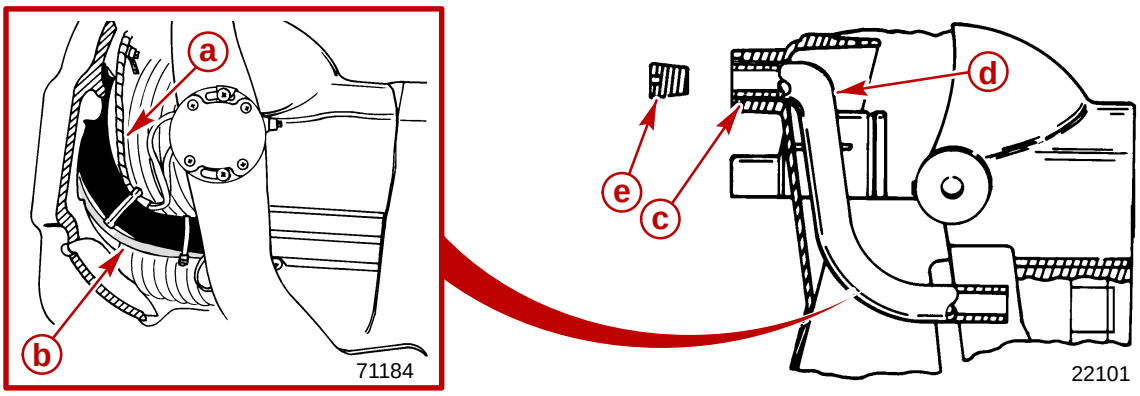
3. Install the block-off plate with new gasket. Secure with screws and lockwashers. Torque the screws.




**a** - Block-Off Plate
**b** - Gasket
**c** - Screw
**d** - Lockwasher

| Description | Nm | lb-in. | lb-ft |
|---|---|---|---|
| Screw, Block-Off Plate | 5 | 45 | |

4. Move the trim limit switch wires and speedometer hose aside. Reach between the gimbal housing and the bell housing and detach the water hose from the gimbal housing where the tapered insert was removed in Step 2.




**a** - Trim Limit Switch Wires
**b** - Speedometer Hose
**c** - Gimbal Housing
**d** - Water Hose
**e** - Tapered Insert

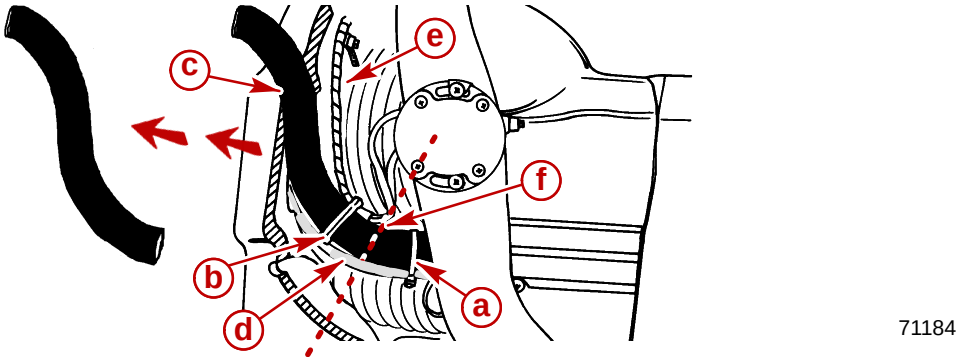
**⚠ WARNING**

**Avoid water leakage into boat. Damage to U-joint bellows could result in water entering the boat. Do not damage the U-joint bellows when removing a section of the water hose attached between the gimbal housing and bell housing.**

***NOTE:*** *Move the trim limit switch wires and speedometer hose to avoid damaging them when cutting the water hose. The existing tie strap and clip can be reused if they are moved and repositioned after the hose is cut.*

5. Cut completely through the water hose 127 mm (5 in.) in front of the aft end of the hose where it is fitted into the bell housing. in the area shown. Do NOT damage the U-joint bellows. Discard loose hose piece.

6. Secure the trim limit switch wires and speedometer hose to the remaining section of water hose using existing tie strap and clip.



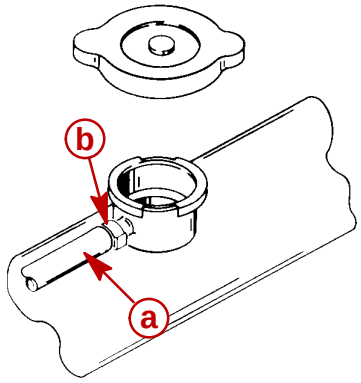

**a** - Tie Strap
**b** - Clip
**c** - Water Inlet Hose
**d** - Speedometer Hose
**e** - Trim Limit Wire Harness
**f** - Cutting Area

# Coolant Recovery Bottle

**⚠ CAUTION**

**Avoid engine overheating and subsequent damage to the engine. The coolant recovery system will not operate properly without proper sealing. The plastic tubing MUST seal *completely* at the connections.**

1. Connect the plastic tubing to the bayonet fitting on the heat exchanger. Secure with the tubing clamp provided.




70548

**a** - Plastic Tubing
**b** - Tubing Clamp

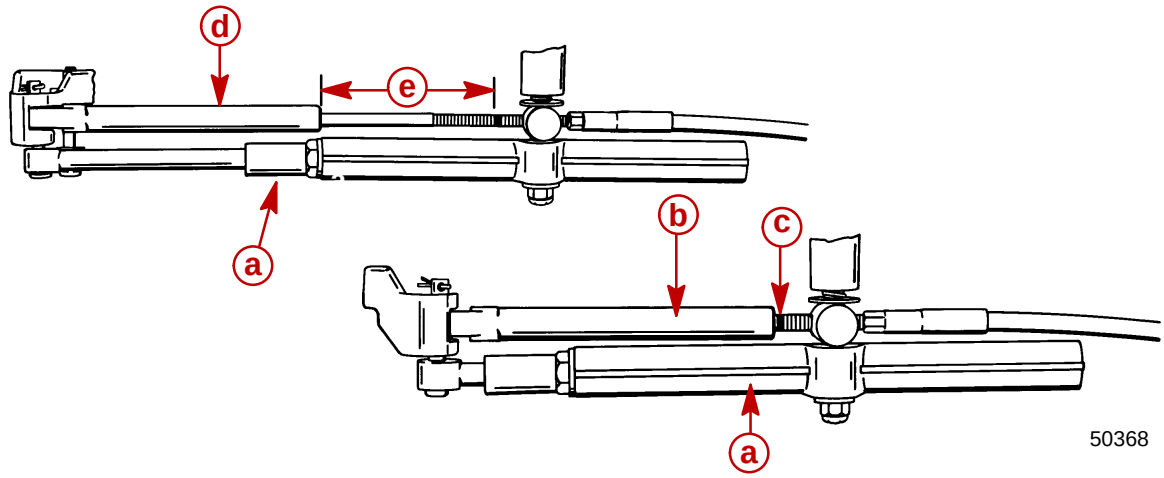
2. Remove the cap from the coolant recovery reservoir and fill to the FULL mark with coolant solution. Reinstall the cap.
3. Recheck the coolant level after the first open-throttle boat test and add coolant, if necessary.
4. Maintain the coolant level in the coolant recovery reservoir between the ADD and FULL marks with the engine at normal operating temperature.

# Shift Cable Installation

## Alpha Models - Drive Unit Not Installed

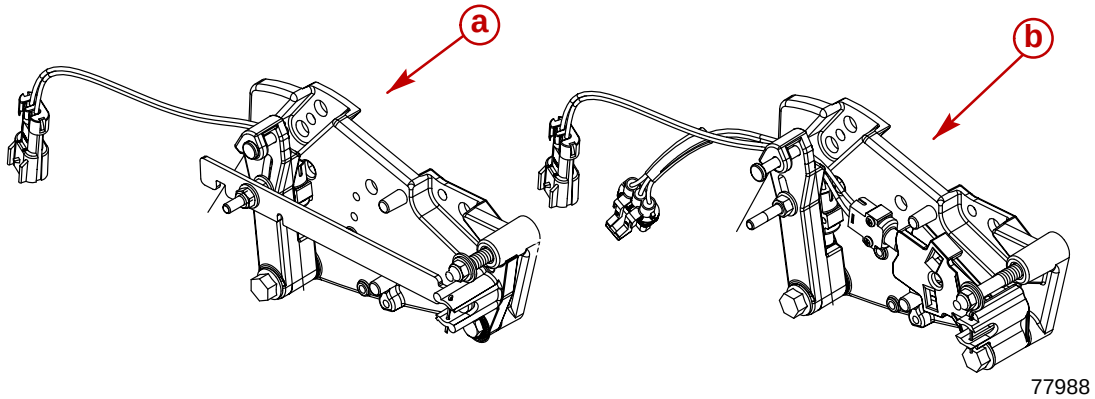
We recommend the use of a Quicksilver remote control and cable. Refer to *Mercury Precision Parts / Quicksilver Accessories Guide* for selection. However, if a control other than Quicksilver is to be used, the control must provide a shift cable travel (at the shift plate end) of 73 mm (2-7/8 in.) to 80 mm (3-1/8 in.) with a 8 kg (18 lb.) load applied to the cable end guide.

***NOTE:*** *On engines with Alpha drives, the measurement indicated above can be taken by installing the remote control shift cable and using the shift assist assembly (provided) to place the proper load on the shift cable.*




50368

**a** - Shift Assist Assembly
**b** - Remote Control Shift Cable - In Forward Gear Position
**c** - Edge Of Cable End Guide
**d** - Remote Control Shift Cable - In Reverse Gear Position
**e** - Measurement Taken from Mark To Edge Of Cable End Guide: 73 mm (2-7/8 in.) to 80 mm (3-1/8 in.)



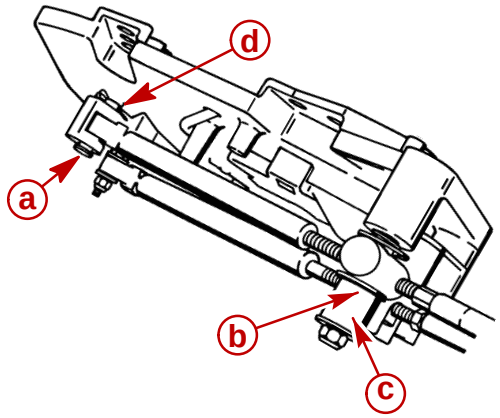

77988

**a** - Bravo Shift Plate
**b** - Alpha Shift Plate

**IMPORTANT: If the boat is being equipped with a REMOTE CONTROL THAT HAS SEPARATE SHIFT AND THROTTLE LEVERS, the shift assist assembly that is shipped with the engine should NOT be used. The use of the shift assist assembly with this type of remote control can cause the shift lever to move out of gear unexpectedly.**

The following kit will have to be ordered to connect the remote control shift cable when the shift assist assembly is not used.

Spacer Kit 23-11284A1




50310

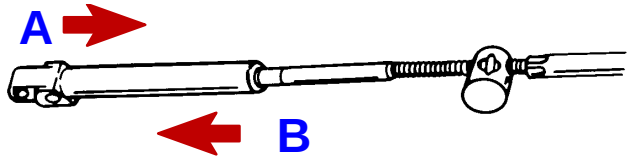
**a** - Clevis Pin
**b** - Washer
**c** - Spacer
**d** - Cotter Pin

***NOTE:*** *Do not discard the shift assist assembly until after it is used in step 3., following.*

**IMPORTANT: The shift cable must be connected at the remote control for the appropriate rotation (LH or RH) drive unit, as explained following:**

RIGHT HAND ROTATION - The control cable will have to be installed in the remote control so that the cable end will move in direction "**A**" when the shift handle is placed in the FORWARD position.

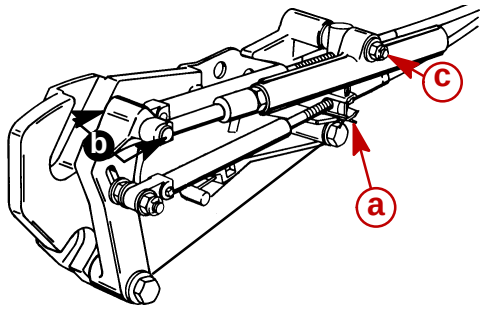
LEFT HAND ROTATION - The control cable will have to be installed in the remote control so that the cable end will move in direction "**B**" when the shift handle is placed in the FORWARD position.




71656

**IMPORTANT: Use the following procedure to temporarily install the shift cables if the boat will be shipped without the drive unit installed. (This is NOT an adjustment procedure.)**

1. Remove the shift cable attaching hardware.

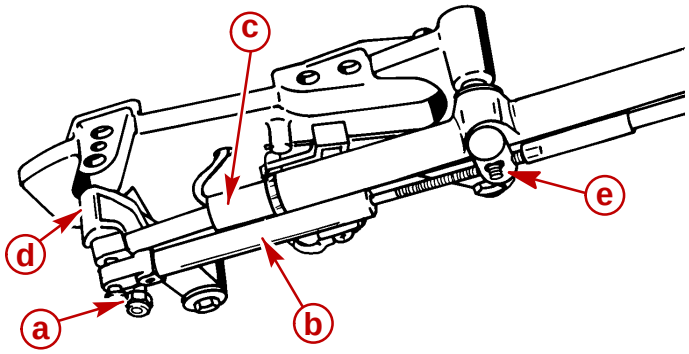



50308

**a** - Cotter Pin
**b** - Clevis Pin And Cotter Pin
**c** - Washer And Locknut

2. Place the remote control shift lever in the NEUTRAL position.

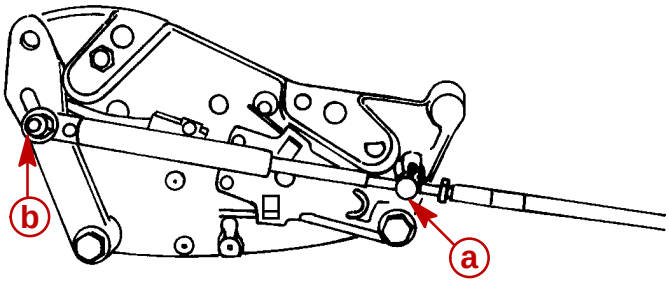
3. Temporarily install the clevis pin through the remote control shift cable end guide, the shift assist assembly end and into the hole in the shift lever. Then adjust the brass barrel so that the hole in the barrel aligns with the anchor stud.




50308

**a** - Clevis Pin
**b** - Shift Cable End Guide
**c** - Shift Assist Assembly End
**d** - Shift Lever
**e** - Brass Barrel (On Stud)

4. Remove the remote control shift cable and the shift assist assembly.
5. Install the drive unit shift cable as shown. Secure the brass barrel in the barrel retainer with the cotter pin and spread both prongs. Secure the cable end guide with the washers (one on each side of end guide) and the locknut. Tighten the locknut until it contacts, then loosen 1/2 turn.

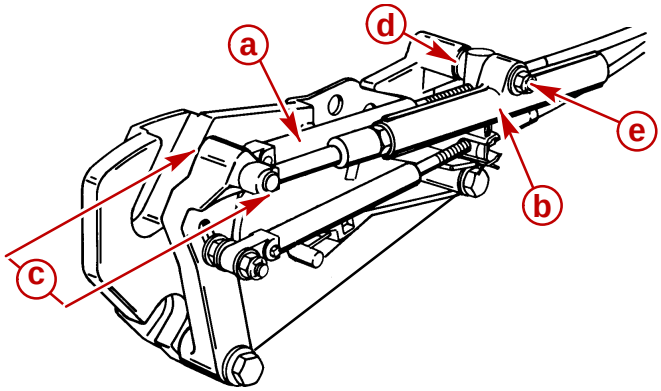



75415

**Without Shift Assist Assembly**

**a** - Cotter Pin
**b** - Locknut And Washers

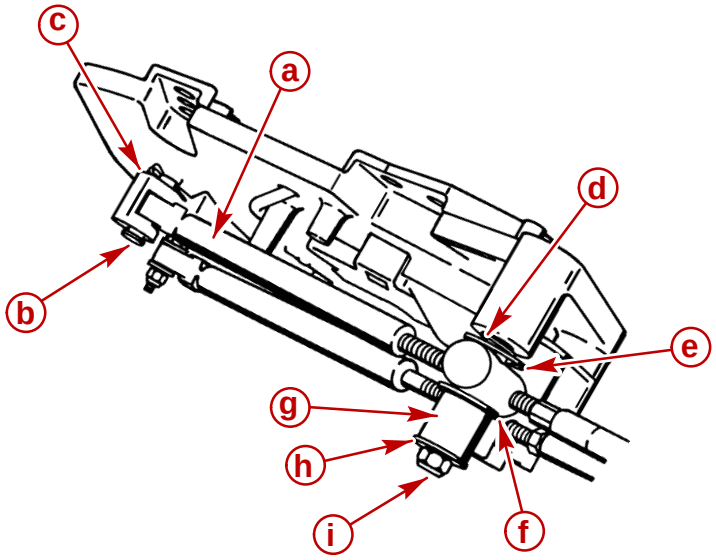
6. Install the remote control shift cable (with or without the shift assist assembly as applicable) and secure with the hardware as shown. Tighten the locknut.




50308

**With Shift Assist Assembly**

- **a** - Remote Control Shift Cable
- **b** - Shift Assist Assembly
- **c** - Clevis Pin And Cotter Pin
- **d** - Large I.D. Washer
- **e** - Small I.D. Washer And Locknut




50310

**Without Shift Assist Assembly**

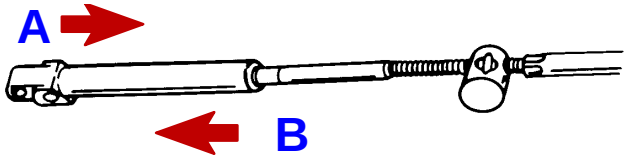
- **a** - Remote Control Shift Cable
- **b** - Pin
- **c** - Cotter Pin (Existing)
- **d** - Spring (Existing)
- **e** - Washer (Existing)
- **f** - Washer
- **g** - Spacer
- **h** - Washer (Existing)
- **i** - Locknut (Existing)

# Bravo Models

***NOTE:*** *Using Adjustment Tool (91-12427), the shift cables can be adjusted with or without the sterndrive installed, using the following procedure.*

**IMPORTANT: The sterndrive unit propeller rotation is determined by the shift cable installation in the remote control.**

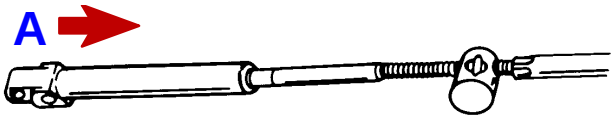
- **Bravo One/Two - If the shift cable end guide moves in direction A when the control lever is placed in Forward, the remote control is set up for RIGHT HAND (RH) propeller rotation.**
- **Bravo One/Two - If the shift cable end guide moves in direction B when the control lever is placed in Forward, the remote control is set up for LEFT HAND (LH) propeller rotation.**




71656

**Arrow Indicates Direction Of Motion**

- **Bravo Three - Front propeller on the sterndrive unit is always LH Rotation and the rear propeller is always RH Rotation. The shift cable end guide must move in direction A, when the control lever is placed in Forward gear position.**

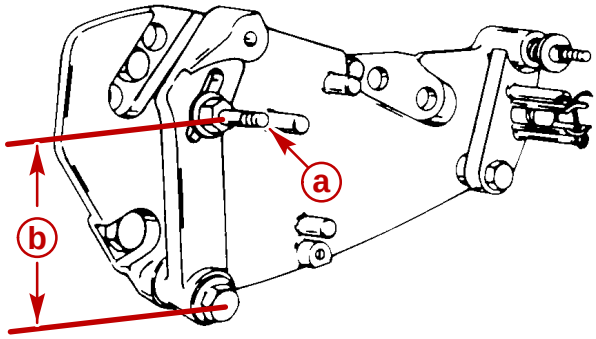



71656

**IMPORTANT: When installing the shift cables, ensure that the cables are routed in such a way as to avoid sharp bends and/or contact with moving parts. Do NOT fasten any items to the shift cables.**

1. Install the shift cable into the remote control. Refer to the remote control manufacturer's instructions.

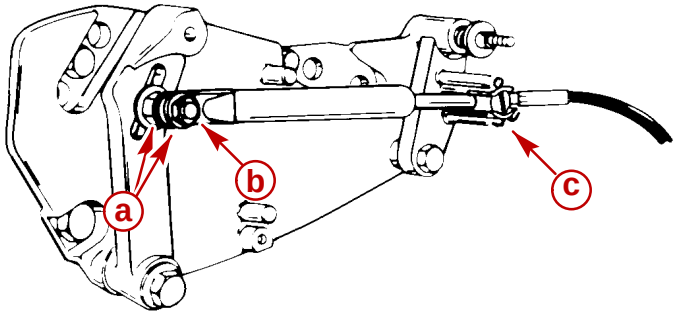
2. Loosen the stud and move it to the dimension shown. Retighten the stud.




71657

**a** - Stud
**b** - 76 mm (3 in.) (Center Of Pivot Bolt To Center Of Stud)

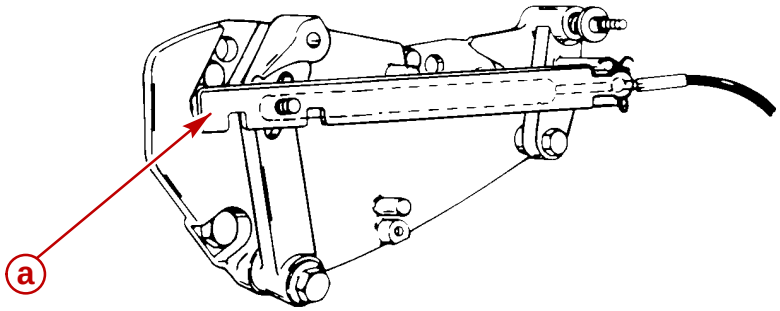
3. Install the sterndrive unit shift cable.
4. Tighten the locknut until it contacts and then loosen 1/2 turn.
5. Insert the cotter pin from the top and spread the ends.




71658

**a** - Washers (2)
**b** - Locknut
**c** - Cotter Pin

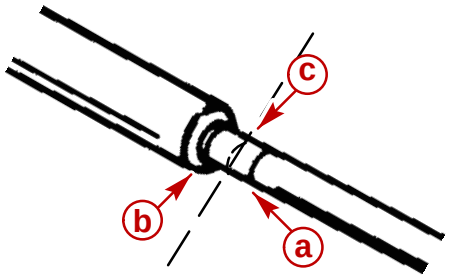
6. Place the adjustment tool over the sterndrive unit shift cable, as shown. Hold the tool in place with a piece of tape over the barrel retainer.




71659

**a -** Adjustment Tool

7. Locate the center of the remote control and the control cable play (backlash).
   a. Shift the remote control to NEUTRAL.
   b. Push in on the control cable end with enough pressure to remove the play and mark the position **"a"** on the tube.
   c. Pull out on the control cable end with enough pressure to remove the play and mark the position **"b"** on the tube.
   d. Measure the distance between marks **"a"** and **"b"** and mark the position **"c"** half-way between marks **"a"** and **"b"**.




71656

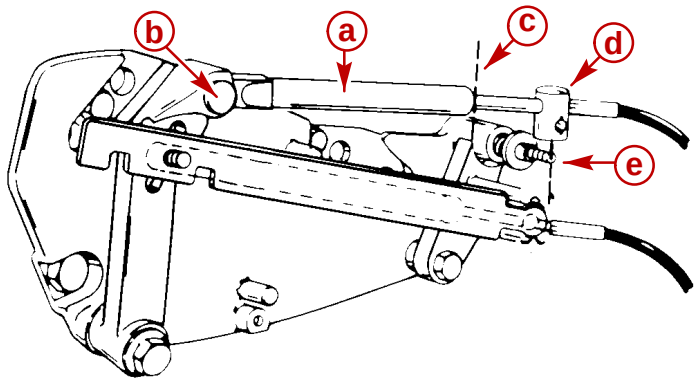
**IMPORTANT: Ensure that center mark "c" remains aligned with the control cable end guide edge when making the following adjustment.**

8. Temporarily install the control cable end guide into the shift lever and insert the anchor pin.
9. Adjust the control cable barrel so that the hole in the barrel centers with the vertical centerline of the stud. Ensure that the backlash center mark is aligned with the edge of the control cable end guide.

**⚠ CAUTION**

**Do NOT attempt to install or remove the control cable barrel from the stud without first removing the end guide anchor pin from the shift lever and removing the cable. Attempting to bend the control cable to install or remove the barrel will place undue stress on the cable end guide and the shift lever and damage to both could occur.**

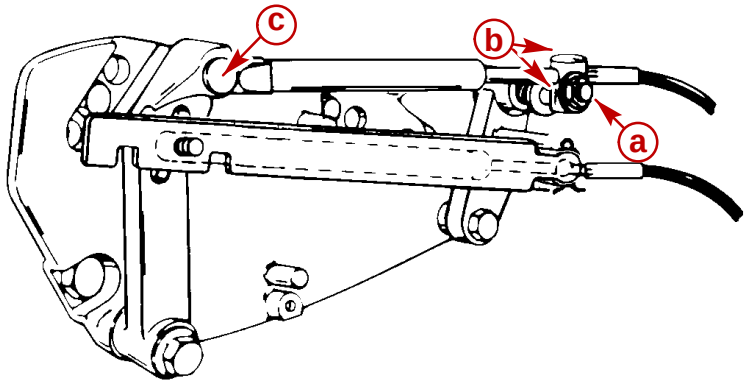
10. Remove the control cable end guide from the shift lever by removing the anchor pin.




71660

**a** - Control Cable End Guide
**b** - Anchor Pin
**c** - Backlash Center
**d** - Control Cable Barrel
**e** - Stud

11. Install the control cable.
12. Install the washer and the locknut.
13. Tighten the locknut until it contacts and then loosen 1/2 turn.
14. Insert the cotter pin from the top and spread the ends.




71661

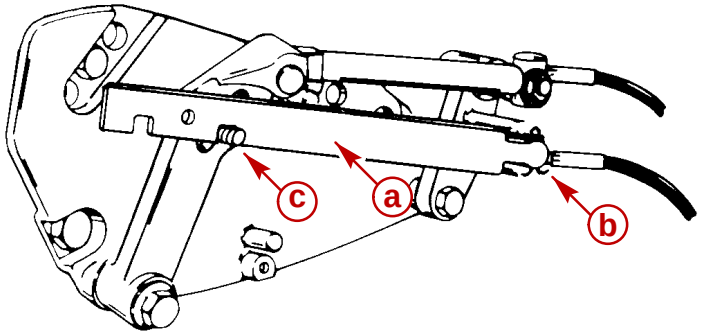
**a** - Locknut
**b** - Washers - Both Sides Of Barrel
**c** - Anchor Pin
**d** - Cotter Pin (Not Shown)

15. Remove the adjustment tool.
16. Shift the remote control lever into the full forward position. Place the end of the adjustment tool in the barrel retainer.

**RH Rotation Bravo One**, **Two And Three Models:** Rear slot in the tool should fit over the shift lever stud.

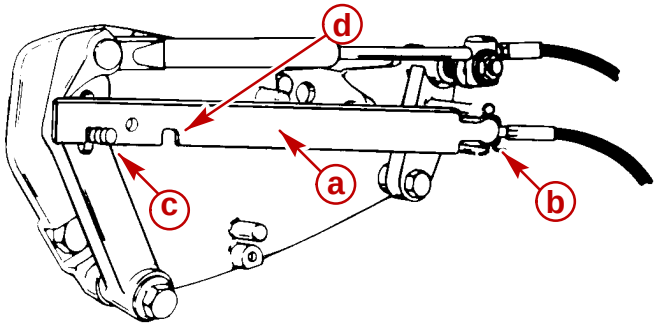
**LH Rotation Bravo One And Two Models:** Forward slot in the tool should fit over the shift lever stud.

If the slot does not fit over the stud, loosen the shift lever stud and slide the stud up or down until the slot in the tool fits over the stud. When the adjustment is correct, retighten the stud.




71662

**RH Rotation Bravo One, Two And Three**




71663

**LH Rotation Bravo One And Two**

- **a** - Adjustment Tool
- **b** - Barrel Retainer
- **c** - Shift Lever Stud
- **d** - Shift Lever Adjustment Slot

17. Remove the adjustment tool.
18. Lubricate the shift cable pivot points.

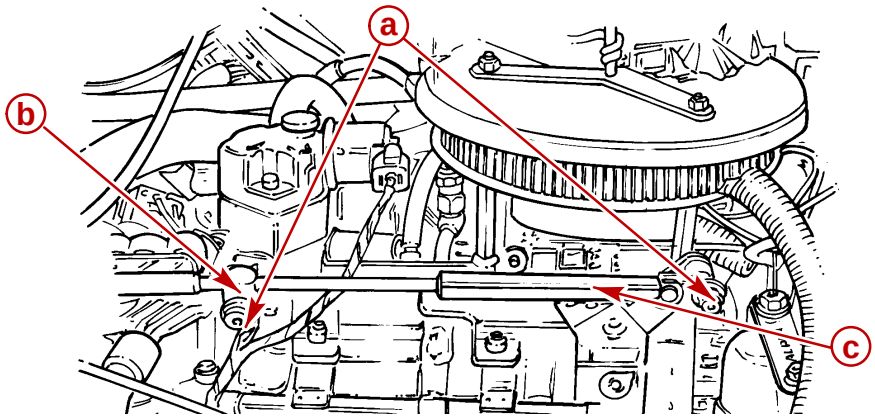
| Description | Where Used | Part Number |
|---|---|---|
| Engine Oil | Shift Cable Pivot Points | Obtain Locally |

# Throttle Cable Installation and Adjustment

1. Place the remote control handles in the NEUTRAL IDLE position.

**IMPORTANT: Ensure that the cable is routed to avoid sharp bends and/or contact with moving parts. Do NOT fasten any items to the throttle cable. The outer cable must be free to move when the cable is actuated.**

2. Install the cable end guide on the throttle lever, then push the cable barrel end lightly toward the throttle lever end. (This will place a slight preload on the shift cable to avoid slack in the cable when moving the remote control lever.) Adjust the barrel on the throttle cable to align with the hole in the anchor plate. Ensure that the hole in the barrel positions the cable as shown.

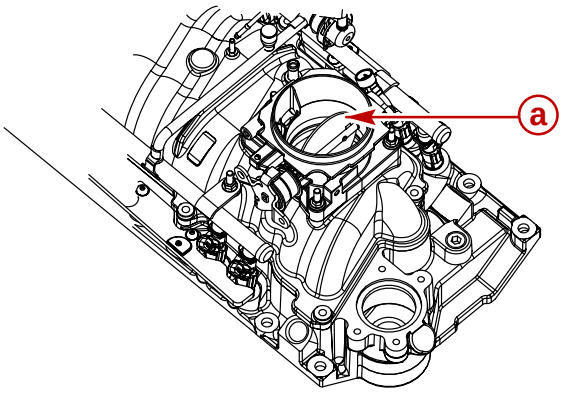



78033

**Typical**

- **a** - Flat Washer And Locknut
- **b** - Cable Barrel
- **c** - End Guide

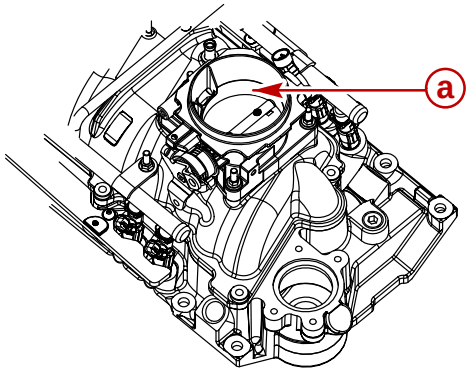
3. Secure the throttle cable with the hardware as shown and tighten securely. Loosen locknut 1/2 turn.
4. Place remote control throttle lever in the wide open throttle (WOT) position. Ensure that throttle plates are completely open.




77939

**a -** Throttle Plate

5. Return remote control throttle lever to IDLE position and ensure that throttle lever is completely closed.




77939

**a -** Throttle Plate

## Battery Connection

**IMPORTANT: Engine electrical system is negative (–) ground.**

1. Connect engine positive (+) battery cable (usually RED) to positive (+) battery terminal.
2. Connect engine negative (–) battery cable (usually BLACK) to negative (–) battery terminal.
3. Connect Power Trim pump BLACK (–) battery cable to negative (–) battery terminal and trim pump RED (+) battery cable to positive (+) battery terminal.
4. Make sure that all battery terminal connections are tight. Then spray terminals with a battery connection sealant to help retard corrosion.

## Engine Cover Installation

1. Install the flame arrestor and secure with the bracket.
2. Torque the bolts.

| Description | Nm | lb-in. | lb-ft |
|---|---|---|---|
| Flame Arrestor Bolts | 12 | | 9 |

3. Install the engine cover and tighten the knob securely.

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# ENGINE MECHANICAL

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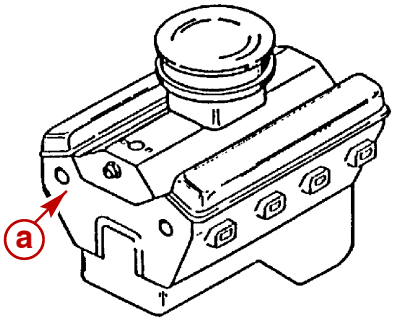
# Identification

The Mercury MerCruiser Model can be determined by looking at the last two or three letters of the engine code stamped into the engine block. This code number is stamped on all Mercury MerCruiser power packages and replacement partial engines, but not replacement engine block assemblies.

If the engine serial number and/or model decals are missing, the engine code letters may help in determining the engine models.




72312

**a** - Location Of Engine Code

The following is a list of Mercury MerCruiser engines and their respective GM code letters.

| Sterndrive (MCM) | Code |
|---|---|
| 4.3L MPI Alpha and Bravo | 2LB |

# General Specifications

## 4.3 liter (262 cid)

| | | |
|---|---|---|
| Displacement | | 4.3 liter (262 cid) |
| Bore | | 101.60 mm (4.012 in.) |
| Stroke | | 88.39 mm (3.480 in.) |
| Firing Order | | 1-6-5-4-3-2 |
| Compression Ratio | | 9.2:1 |
| Heads | | Cast Iron |
| Intake Manifold - Two Piece | Upper | Aluminum |
| | Lower | Cast Iron |
| Block | | Cast Iron (2 Bolt Main Bearing Caps) |
| Rods | | Forged Steel |
| Crankshaft | | Cast Iron |
| Pistons | | Cast Aluminum |
| Camshaft | | Cast Iron |

# Engine Specifications - 4.3 liter (262 cid)

## Cylinder Head

| Description | | 4.3 liter (262 cid) |
|---|---|---|
| Surface Flatness | At Exhaust Manifold Deck | 0.05 mm (0.0020 in.) |
| | At Engine Block Deck - Within An 152 mm (6.0 in.) Area | 0.10 mm (0.0039 in.) |
| | At Intake Manifold Deck | 0.10 mm (0.0039 in.) |
| | Intake Manifold Flatness | 0.10 mm (0.0039 in.) |

## Cylinder Bore

| Description | | 4.3 liter (262 cid) |
|---|---|---|
| Diameter | | 101.618-101.643 mm (4.0007-4.0017 in.) |
| Out Of Round | Production | 0.0127 mm (0.0005 in.) Maximum |
| | Service | 0.05 mm (0.0020 in.) Maximum |
| Taper | Production - Thrust Side | 0.012 mm (0.0005 in.) Maximum |
| | Production - Relief Side | 0.025 mm (0.0010 in.) Maximum |
| | Service | 0.025 mm (0.0010 in.) Over Production |

## Oil Pump

| Description | Height |
|---|---|
| Oil Pump Dowel Pin | 6.4 mm (0.2520 in.) |

## Piston Bore Clearance

| Description | 4.3 liter (262 cid) |
|---|---|
| Production | 0.018-0.061 mm (0.0007-0.0024 in.) |
| Service | 0.075 mm Maximum (0.0029 in. Maximum) |

# Engine Specifications - 4.3 liter (262 cid) (continued)

## Piston Rings

### TOP COMPRESSION

| Description | | 4.3 liter (262 cid) |
|---|---|---|
| Groove Clearance | Production | 0.030-0.070 mm (0.0012-0.0028 in.) |
| | Service | 0.030-0.085 mm (0.0012-0.0033 in.) |
| Gap | Production | 0.25-0.40 mm (0.010-0.016 in.) |
| | Service | 0.25-0.40 mm (0.010-0.020 in.) |

### SECOND COMPRESSION

| Description | | 4.3 liter (262 cid) |
|---|---|---|
| Groove Clearance | Production | 0.040-0.080 mm (0.0015-0.0031 in.) |
| | Service | 0.030-0.085 mm (0.0012-0.0033 in.) |
| Gap | Production | 0.38-0.58 mm (0.015-0.023 in.) |
| | Service | 0.38-0.80 mm (0.015-0.031 in.) |

### OIL CONTROL

| Description | | 4.3 liter (262 cid) |
|---|---|---|
| Groove Clearance | Production | 0.046-0.196 mm (0.0018-0.0077 in.) |
| | Service | 0.046-0.200 mm (0.0018-0.0079 in.) |
| Gap | Production | 0.25-0.76 mm (0.0098-0.0299 in.) |
| | Service | 0.005-0.090 mm (0.0002-0.0035 in.) |

## Piston Pin

| Description | | 4.3 liter (262 cid) |
|---|---|---|
| Diameter | | 23.545-23.548 mm (0.9270-0.9271 in.) |
| Clearance | Production | 0.013-0.023 mm (0.0005-0.0009 in.) |
| | Service Limit | 0.025 mm Maximum (0.0010 in. Maximum) |
| Fit In Connecting Rod | | 0.012-0.048 mm (0.0005-0.0019 in.) Interference |

# Engine Specifications - 4.3 liter (262 cid) (continued)

## Crankshaft

### MAIN BEARING JOURNAL

| Description | | 4.3 liter (262 cid) |
|---|---|---|
| Diameter | Number 1 | 62.199-62.217 mm (2.4488-2.4495 in.) |
| | Number 2, 3 | 62.191-62.215 mm (2.4485-2.4494 in.) |
| | Number 4 | 62.179-62.203 mm (2.4480-2.4489 in.) |
| Taper | Production | 0.007 mm (0.0003 in.) Maximum |
| Out Of Round | Production | 0.005 mm (0.0002 in.) Maximum |
| | Service | 0.025 mm (0.0010 in.) Maximum |

### MAIN BEARING CLEARANCE

| Description | | 4.3 liter (262 cid) |
|---|---|---|
| Production | Number 1 | 0.018-0.053 mm (0.0007-0.0021 in.) |
| | Number 2, 3, 4 | 0.028-0.058 mm (0.0011-0.0023 in.) |
| Service | Number 1 | 0.0254-0.050 mm (0.0010-0.0020 in.) |
| | Number 2, 3, 4 | 0.025-0.063 mm (0.0010-0.0025 in.) |

### CONNECTING ROD JOURNAL

| Description | | 4.3 liter (262 cid) |
|---|---|---|
| Diameter | | 57.116 - 57.148 mm (2.2487-2.2497 in.) |
| Taper | Production | 0.00508 mm (0.0003 in.) Maximum |
| | Service | 0.025 mm (0.0010 in.) Maximum |
| Out Of Round | Production | 0.007 mm (0.0003 in.) Maximum |
| | Service | 0.025 mm (0.0010 in.) Maximum |

### MISCELLANEOUS

| Description | 4.3 liter (262 cid) |
|---|---|
| Runout | 0.025 mm (0.0010 in.) |
| End Play (Thrust Clearance) | 0.05-0.20 mm (0.0020-0.0079 in.) |

# Engine Specifications - 4.3 liter (262 cid) (continued)

## Connecting Rod

### CONNECTING ROD BEARING

| Description | | 4.3 liter (262 cid) |
|---|---|---|
| Clearance | Production | 0.038-0.078 mm (0.0015-0.0031 in.) |
| | Service Limit | 0.025-0.063 mm (0.0010-0.0025 in.) |
| Rod Side Clearance | | 0.15-0.44 mm (0.0059-0.017 in.) |

## Valve

### CLEARANCE (LASH)

| Description | 4.3 liter (262 cid) |
|---|---|
| Intake and Exhaust | Net Lash<br>No Adjustment |

### LIFTER

| Description | | 4.3 liter (262 cid) |
|---|---|---|
| Type | | Hydraulic Roller |
| Rocker Arm Ratio | | 1.50 : 1 |
| Valve Lift | Intake | 10.527 mm (0.4140 in.) |
| | Exhaust | 10.879 mm (0.4280 in.) |

### HEAD AND STEM

| Description | | 4.3 liter (262 cid) |
|---|---|---|
| Valve Diameter | Intake | 46.74 mm (1.84 in.) |
| | Exhaust | 38.1 mm (1.5000 in.) |
| Face Angle | Intake | 45 degrees |
| | Exhaust | 45 degrees |
| Margin After Surfacing | Intake | 0.79 mm (0.0311 in.) Minimum |
| Production Stem Diameter | Intake | 8.661 - 8.679 mm (0.3410 - 0.3417 in.) |
| | Exhaust | |
| Service Stem Oversize Diameter | Exhaust Only | + 0.774 mm (+0.0305 in.) |
| Valve Stem Oil Seal | Installed Height [1] | 1 - 2 mm (0.0394 - 0.0787 in.) |

[1] Measured from the top of the valve guide bevel to the bottom of the oil stem seal.

# Engine Specifications - 4.3 liter (262 cid) (continued)

## Valve (continued)

### STEM CLEARANCE

| Description | | 4.3 liter (262 cid) |
|---|---|---|
| Production | Intake | 0.025-0.069 mm (0.0010-0.0027 in.) |
| | Exhaust | 0.025-0.069 mm (0.0010-0.0027 in.) |
| Service | Intake | 0.025-0.094 mm (0.0010-0.0037 in.) |
| | Exhaust | 0.025-0.094 mm (0.0010-0.0037 in.) |

### SEAT

| Description | | 4.3 liter (262 cid) |
|---|---|---|
| Seat Angle | Intake And Exhaust | 46 degrees |
| Top Correction Cut Angle | | 30 degrees |
| Bottom Correction Cut Angle | | 60 degrees |
| Width | Intake | 1.016-1.651 mm (0.040-0.065 in.) |
| | Exhaust | 1.65-2.489 mm (0.0650-0.0980 in.) |
| Runout | Intake And Exhaust | 0.05 mm (0.0020 in.) Maximum |

### SPRING

| Description | | 4.3 liter (262 cid) |
|---|---|---|
| Free Length | | 51.3 mm (2.02 in.) |
| Pressure | Valve Closed | 338-374 N (76-84 lb.) at 43.2 mm (1.7008 in.) |
| | Valve Open | 832-903 N (187-203 lb.) at 32.3 mm (1.2717 in.) |
| Installed Height | Intake | 42.92-43.43 mm (1.6898-1.7098 in.) |
| | Exhaust | |
| Approximate Number Of Coils | | 4 |

# Engine Specifications - 4.3 liter (262 cid) (continued)

## Camshaft

| Description | 4.3 liter (262 cid) |
|---|---|
| Journal Diameter | 47.440-47.490 mm (1.8677-1.8697 in.) |
| Journal Out Of Round | 0.025 mm (0.0010 in.) Maximum |
| Camshaft Runout | 0.065 mm (0.0026 in.) Maximum |

## Timing Chain

| Description | 4.3 liter (262 cid) |
|---|---|
| Chain Deflection | 11 mm (0.4331 in.) Maximum |

## Flywheel

| Description | | 4.3 liter (262 cid) |
|---|---|---|
| Runout | | 0.203 mm (0.0080 in.) Maximum |
| Lobe Lift | Intake | 7.20-7.30 mm (0.283-0.287 in.) |
| | Exhaust | 6.97-7.07 mm (0.274-0.278 in.) |
| End Play | | 0.0254-0.2286 mm (0.0010-0.0090 in.) |

# Torque Specifications

| Description | | Nm | lb-in. | lb-ft |
|---|---|---|---|---|
| Alternator Brace-To-Alternator Bolt | | 28 | | 21 |
| Alternator Brace-To-Engine Bolt | | 41 | | 30 |
| Alternator-To-Mounting Bracket Bolt | | 48 | | 35 |
| By-Pass Valve Block Adapter Bolt | | 27 | | 20 |
| Alternator Mounting Bracket Bolt | | 41 | | 30 |
| Camshaft Position Sensor Bolt | | 9 | 80 | |
| Camshaft Thrust Plate Retainer Bolt | | 12 | 106 | |
| Camshaft Sprocket Bolt | | 25 | | 18 |
| Connecting Rod Nut - 4.3 liter (262 cid) | | | | |
| | First Pass | 27 | | 20 |
| | Final Pass (Angle Torque) | + 70 degrees | | |
| Coolant Drain Hole Plug | | | | |
| | Left Front | 60 | | 44 |
| | Sides | 20 | | 15 |
| Coupler-To-Flywheel Bolts (MCM) | | 48 | | 35 |
| Crankshaft Main Bearing Cap Bolt and Stud - Preferred Method | | | | |
| Two Bolt Type Cap | First Pass | 20 | | 15 |
| | Final Pass | + 73 degrees | | |
| Crankshaft Main Bearing Cap Bolt and Stud - Optional Method | | | | |
| Two Bolt Type Cap | One Pass - All Bolts Evenly Tightened | 105 | | 77 |

# Torque Specifications (continued)

| Description | | | Nm | lb-in. | lb-ft |
|---|---|---|---|---|---|
| Crankshaft Balancer (Torsional Damper) Bolt | | | 95 | | 70 |
| Crankshaft Oil Deflector Nut | | | 40 | | 30 |
| Crankshaft Position Sensor Bolt | | | 9 | 80 | |
| Crankshaft Pulley Bolt | | | 58 | | 43 |
| Cylinder Head Bolt - Preferred Method | | | | | |
| All Bolts In Sequence | First Pass | | 30 | | 22 |
| In Sequence Angle Torque | Final Pass | Long Bolts | + 75 degrees | | |
| | | Medium Bolts | + 65 degrees | | |
| | | Short Bolts | + 55 degrees | | |
| Cylinder Head Bolt - Optional Method | | | | | |
| All Bolts In Sequence | First Pass | | 35 | | 26 |
| | Second Pass | | 60 | | 44 |
| | Final Pass | | 90 | | 66 |
| Distributor Cap Bolt | | | 2.4 | 21 | |
| Distributor Hold Down Clamp Bolt | | | 25 | | 18 |
| Exhaust Manifold Cap Screws | | | 27 | | 20 |
| Engine Flywheel Bolt | | | 100 | | 74 |
| Engine Coolant Temperature (ECT) Sensor | | | 20 | | 15 |
| Engine Block Coolant Drain Hole Plug | | | 20 | | 15 |
| Fitting/Bushing | | | 50 | | 37 |
| Flywheel Housing Studs and Bolts | | | 41 | | 30 |
| Flywheel Housing Cover | | | 9 | 80 | |
| Front Cover Bolt | | | 12 | 106 | |
| Front Mount Bracket | | | 41 | | 30 |

# Torque Specifications (continued)

| Description | | Nm | lb-in. | lb-ft |
|---|---|---|---|---|
| Fuel Rail Bracket Bolt | | 6 | 53 | |
| Fuel Rail Retainer Nut | | 3 | 27 | |
| Ignition Coil Bolt | | 12 | 106 | |
| Lower Intake Manifold Bolt (Each Pass In Sequence) | | | | |
| | First Pass | 3 | 27 | |
| | Second Pass | 12 | 106 | |
| | Final Pass | 15 | 132 | |
| Knock Sensor | | 20 | | 15 |
| MAPT Sensor Bolt | | 12 | 106 | |
| Oil Deflector Nut | | 40 | | 30 |
| Oil Filter Adapter (5/16 in. -18) | | 27 | | 20 |
| Oil Filter Adapter Bolt | | 25 | | 18 |
| Oil Gallery Plug | | 20 | | 15 |
| Oil Lines | | 27 | | 20 |
| Oil Pan Bolt or Nut | | 12 | 106 | |
| Oil Pan Stud (Front) | | 6 | 53 | |
| Oil Pan Stud Nut | | 25 | | 18 |
| Oil Pan Fitting Hollow Bolt | | 20 | 180 | |
| Oil Pan Drain Plug | | 25 | | 18 |
| Oil Pressure Switch Fitting | | 15 | | 11 |
| Oil Pump Bolt (To Rear Crankshaft Bearing Cap) | | | | |
| | First Pass | 20 | | 15 |
| | Final Pass | + 65 degrees | | |
| Oil Pump Cover Bolt | | 12 | 106 | |
| Rear Main (Crankshaft) Oil Seal Retainer Bolts and Nuts | | 12 | 106 | |

# Torque Specifications (continued)

| Description | | Nm | lb-in. | lb-ft |
|---|---|---|---|---|
| Rear Mount - Sterndrive (MCM) | | 51 | | 38 |
| Rear Oil Seal Retainer Nuts And Bolts | | 12 | 106 | |
| Rear Oil Seal Retainer Stud | | 6 | 53 | |
| Remote Oil Connector | | 34 | | 25 |
| Remote Oil Filter Adapter Nut / Fitting | | 27 | | 20 |
| Rocker Arm Bolts | | 30 | | 22 |
| Seawater Pump Bracket | | 41 | | 30 |
| Spark Plug | | | | |
| | Initial Installation (New Cylinder Head) | 30 | | 22 |
| | All Subsequent Installations | 15 | | 11 |
| Starter Motor Bolt | | 50 | | 37 |
| Thermostat Housing Bolt | | 41 | | 30 |
| Throttle Body Stud | | | | |
| | Nut | 10 | 88 | |
| | Stud | 9 | 80 | |
| Upper Intake Manifold Stud | | | | |
| | First Pass | 5 | 44 | |
| | Final Pass | 10 | 89 | |
| Valve Cover Bolt | | 12 | 106 | |
| Valve Lifter Guide Retainer Bolt | | 25 | | 19 |
| Water Circulating Pump Bolt | | 45 | | 33 |
| Water Pump Pulley Bolt | | 25 | | 19 |
| Water Temperature Sender | | 27 | | 20 |

# Special Tools

| Kent-Moore Tools<br>29784 Little Mack<br>Roseville, MI 48066<br>Phone: (313) 574-2332<br>(800) 345-2233 | |
|---|---|
| **Description** | **Part Number** |
| Valve Spring Compressor (Cylinder Head On Engine) | J5892 |
| Valve Spring Compressor (Cylinder Head Off Engine) | J8062 |
| Valve Spring Tester | J9666 |
| Valve Guide Cleaner | J8101 |
| Valve Guide Reamer Set | J5830-02 |
| Carbon Remover Brush | J8089 |
| Piston Pin Remover / Installer | J24086-C |
| Piston Ring Groove Cleaner | J3936-03 |
| Piston Ring Compressor | J8037 |
| Connecting Rod Guide Tool (3/8 -24) | J5239 |
| Oil Pump Suction Pipe Installer | J21882 |
| Ball Socket Adapter | J8520-1 |
| Crankshaft Balancer Remover and Installer | J23523-F |
| Front Cover Seal Installer | J35468 |
| Crankshaft Gear and Sprocket Puller | J5825-A |
| Crankshaft Gear and Sprocket Installer | J5590 |
| Air Adapter | J23590 |
| Main Bearing Remover and Installer | J8080 |
| Rear Main Seal Installer | J35621-B |
| Fuel Line Quick Disconnect | J44581 |
| Valve Lifter Remover | J3049-A |
| Pinion Bearing Race Installer - Rear | J5590 |
| Magnetic Base Dial Indicator | J7872 |
| Dial Indicator Set | J8001 |
| Cylinder Bore Ridge Reamer | J24270 |
| Camshaft Bearing Service Kit | J33049 |
| Electronic Torque Angle Meter | J36660-A |
| Balance Shaft Installer | J26996 |
| Balance Shaft Service Kit | J38834 |
| Valve Stem Seal Installer | J42073 |

# Lubricants / Sealants / Adhesives

| Description | Where Used | Part Number |
|---|---|---|
| Loctite 242 | Camshaft rear bearing hole expansion plug | 92-809821 |
| | Camshaft thrust plate retainer bolt | |
| | Engine block core hole expansion plug | |
| | Exhaust manifold bolt | |
| | Fuel rail bolt | |
| | Lower intake manifold bolt | |
| | Throttle body stud | |
| | Upper intake manifold stud | |
| Ultra-Black Loctite 5900 | Crankshaft balancer keyway | 92-809826 |
| | Engine block to the crankshaft rear oil seal housing junction at the oil pan sealing surfaces | |
| | Engine block to the engine front cover junction at the oil pan sealing surfaces | |
| | Engine block at the lower intake manifold sealing surfaces | |
| | Lower intake manifold gaskets | |
| | Front cover seal retainer-to-seal mating surface | |

# Lubricants / Sealants / Adhesives (continued)

| Description | Where Used | Part Number |
|---|---|---|
| Loctite 565 PST (Pipe Sealant With Teflon) | Cylinder head bolts | Obtain Locally |
| | Engine block coolant drain hole plug | |
| | Engine block oil gallery plug | |
| | Engine Coolant Temperature (ECT) sensor | |
| | Expansion cup plug (camshaft rear bearing hole) | |
| | Expansion cup plug (engine block core hole) | |
| | Knock sensor | |
| | Oil dipstick tube | |
| | Oil pressure sender | |
| | Oil gallery plugs | |
| | Oil pressure switch | |
| | Oil pressure switch fitting | |
| | Oil pickup screen pipe to oil pump body | |
| | Water circulating pump bolt | |
| Engine Oil | On all moving parts during assembly as indicated | Obtain Locally |
| 80W Gear Lube | Rocker arm ball stud | Obtain Locally |
| Johnson EP Lube | Lifters, camshafts and camshafts lobes | 92-801779 |
| | Valve pushrods, rocker arm and rocker arm ball contact surfaces | |
| Needle Bearing Assembly Lubricant | Valve stem locks | 92-082868A1 |

# Precautions

**⚠ WARNING**

**Avoid injury or death and power package damage from an electrical shock, fire or explosion. Always disconnect both battery cables from the battery before servicing the power package.**

**⚠ WARNING**

**BE CAREFUL while working on fuel system; gasoline is extremely flammable and highly explosive under certain conditions. Ensure that ignition key is OFF and do not smoke or allow sources of spark and/or open flames in the area.**

**⚠ CAUTION**

**If boat is in the water, seacock must remain closed until engine is to be re-started to prevent water from flowing back into cooling system and/or boat. If boat is not fitted with a seacock, water inlet hose must be left disconnected and plugged to prevent water from flowing back into cooling system and/or boat. As a precautionary measure, attach a tag to the ignition switch or steering wheel of the boat with the warning: Open seacock or reconnect water inlet hose before starting engine.**

**⚠ CAUTION**

**Compressed air could cause injury. Always wear safety glasses while using compressed air.**

**⚠ CAUTION**

**ENVIRONMENTAL HAZARD! Discharge of oil or oil waste into the environment is restricted by law. Do not spill oil or oil waste into the environment when using or servicing your boat. Contain and dispose of oil or oil waste as defined by local authorities.**

**⚠ CAUTION**

**DO NOT operate engine without water flowing through seawater pickup pump, as pump impeller may be damaged and subsequent overheating damage to engine or sterndrive unit may result.**

**IMPORTANT: To provide the initial lubrication during first starting, lubricate all engine moving parts during assembly with clean engine oil, unless otherwise specified.**

# General Information

## Repair Procedures

Some of the repairs in this section must be completed with the engine removed from the boat. Engine removal depends upon the type of repair and boat design. Place the engine on a repair stand for major repairs.

When engine removal is not required, ensure that the battery cables are disconnected at the battery prior to performing any on-board repair procedures.

Lubricate all moving parts during reassembly with clean engine oil or as specified. Apply appropriate lubricant, sealant or adhesive to all fasteners as specified.

## Special Notice

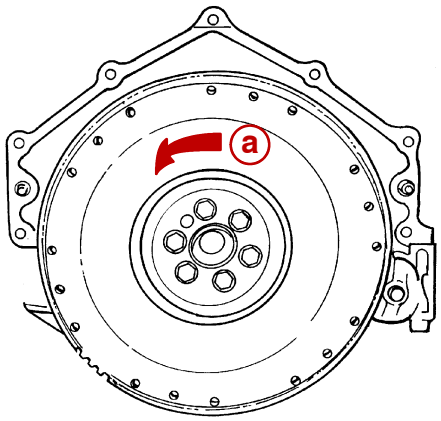
Servicing the cylinder heads and engine block is the primary concern of this section. Some external components that are not mentioned in the procedural steps must be removed. Refer to appropriate sections of this manual for complete service information concerning any component hindering service or repairs to the cylinder heads and engine block.

## Engine Rotation

Engine rotation is described when observed from the rear of the engine (sterndrive end) looking forward (water pump end).

Propeller rotation is not necessarily the same as engine rotation.

**IMPORTANT: All engines covered by this service manual are left hand (LH) rotation.**

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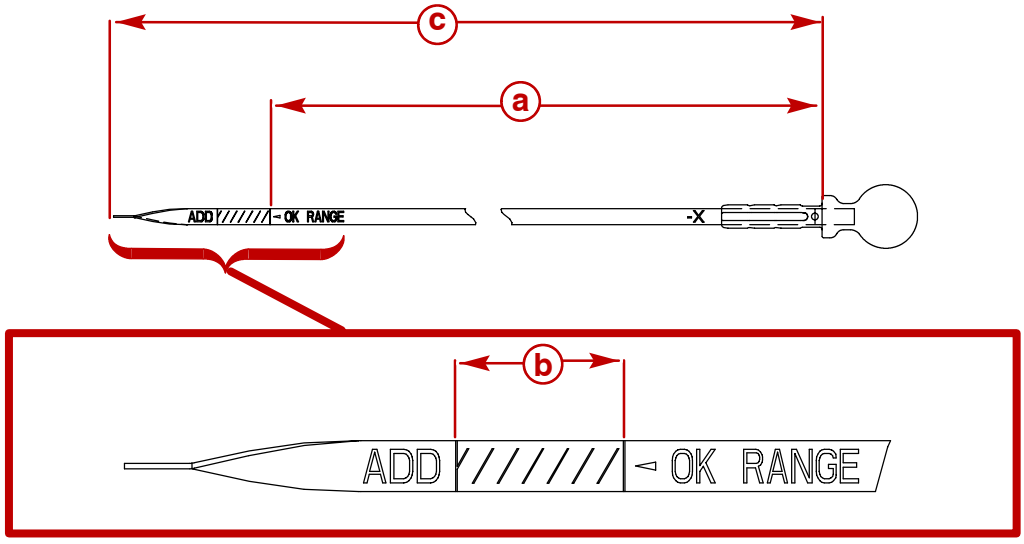
**a** - Left Hand Rotation (Counterclockwise)

# Crankcase Oil Dipstick Measurements

| NOTICE |
|---|
| Unit Of Measurement: millimeters (inches) |

| Part Number | Length A | Length B | Length C | Model |
|---|---|---|---|---|
| 861942-6 | 631 (24-7/8) | 28 (1-1/8) | 698 (27-1/2) | All Models |

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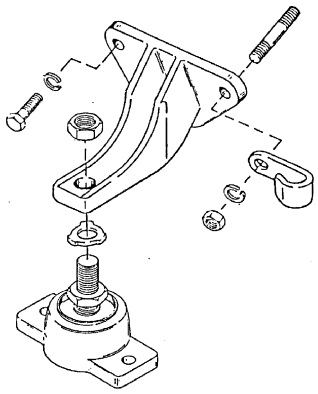
**a** - Length A
**b** - Length B
**c** - Length C

# Engine Mounts

## Exploded Views



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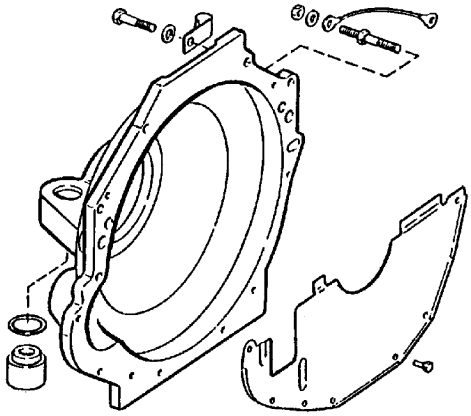
**Front Mount - All Sterndrive (MCM) Models**



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**Rear Mount / Flywheel Housing - All Sterndrive (MCM) Models**

# Valve Cover

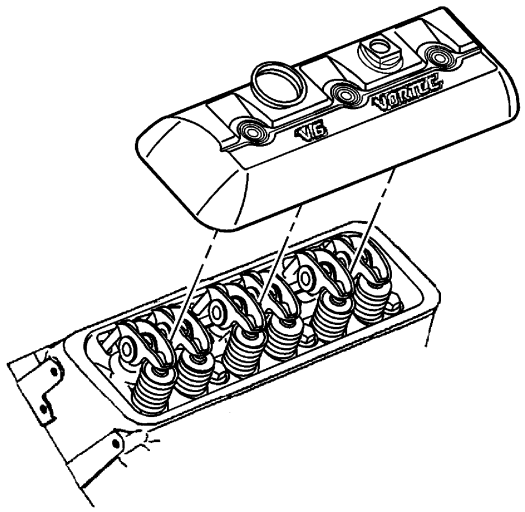
## Removal

***NOTE:*** *It may be necessary to remove the exhaust manifold before removing a valve cover. Refer to SECTION 7 for exhaust manifold removal.*

1. Disconnect crankcase ventilation hoses.
2. Remove any items that interfere with the removal of valve covers.
3. Remove valve covers.

## Cleaning and Inspection

1. Clean gasket material from all sealing surfaces.
2. Put on safety glasses.



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3. Clean sealing surfaces on cylinder head and valve cover with degreaser.

## Installation

1. Place new valve cover gasket in groove on valve cover.
2. Install valve cover. Torque bolts.

| Description | Nm | lb-in. | lb-ft |
|---|---|---|---|
| Valve Cover Bolt | 12 | 106 | |

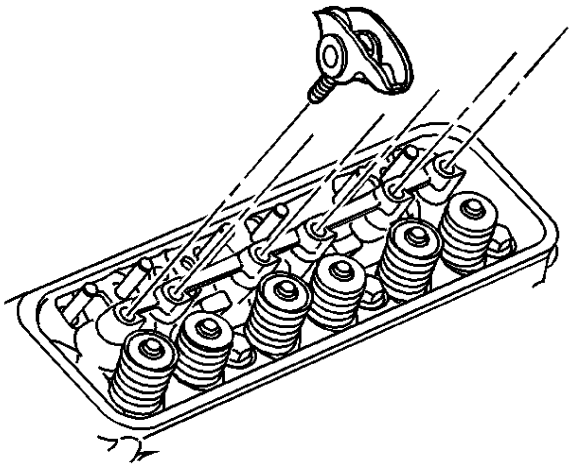
3. Install any items that were removed.
4. Connect crankcase ventilation hoses.
5. Supply cooling water to the power package.
6. Start engine and check for oil leaks.

# Rocker Arm / Valve Pushrod

## Removal

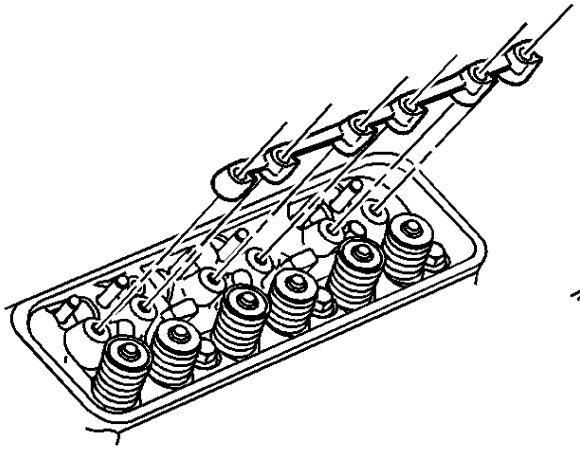
***NOTE:*** *When servicing only one cylinder's rocker arms, bring that cylinder's piston up to TDC (Top Dead Center) before removing rocker arms. When servicing all rocker arms, bring cylinder number 1 piston up to TDC before removing rocker arms.*

1. Remove valve covers.
2. Remove valve rocker arms.

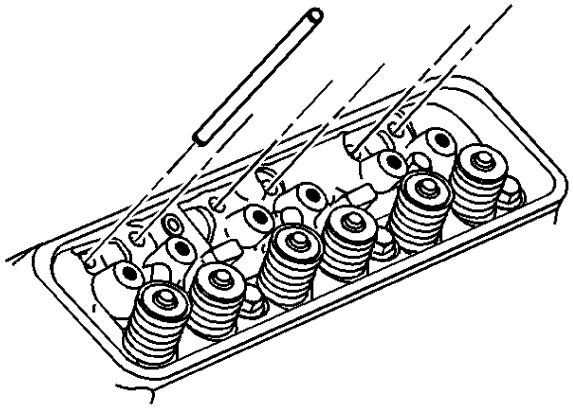


78222

3. Remove the valve rocker arm supports and remove the valve pushrods.



78223



78224

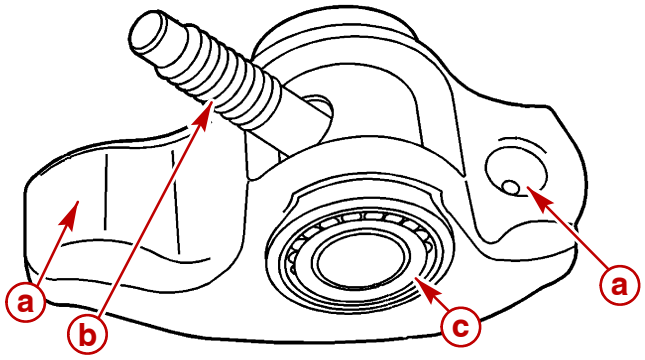
**IMPORTANT: Organize rocker arm assemblies and valve pushrods in a rack for reassembly in their original locations.**

## Cleaning

1. Clean rocker arm assemblies and pushrods.
2. Clean valve pushrod oil passages.
3. Put on safety glasses.
4. Dry parts with compressed air.

## Inspection

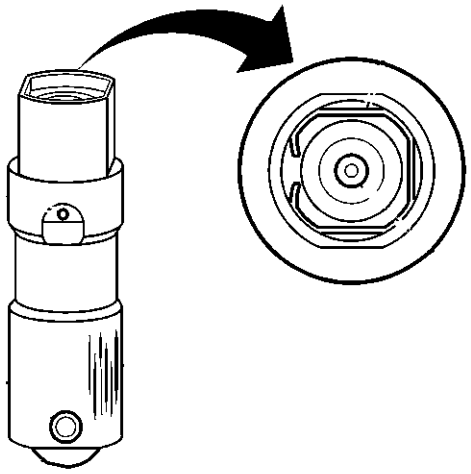
1. Inspect all contact surfaces for excessive wear or scoring.
2. Inspect threads for damage.
3. Inspect pivot for binding or damage.




78232

**a** - Contact Surfaces
**b** - Threads
**c** - Pivot Point

4. Ensure valve pushrod oil passage is not restricted.
5. Roll valve pushrod on a flat surface and inspect shafts for bends.

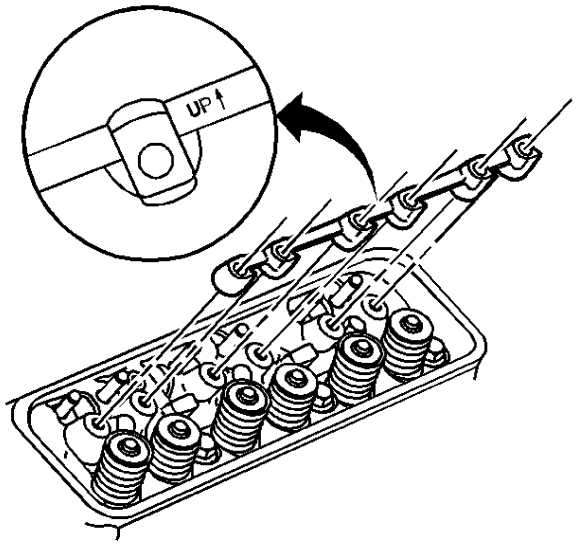


78259

6. Replace all damaged parts.

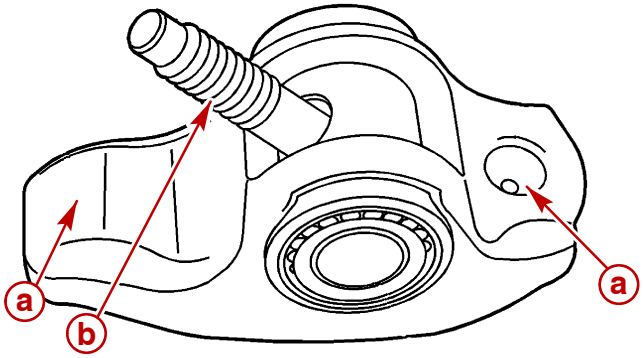
## Installation

1. Lubricate the outer surfaces and ends of valve pushrods.
2. Install the valve pushrods in their original locations. Ensure that the pushrods seat in the lifter socket.
3. Install the rocker arm supports.




78241

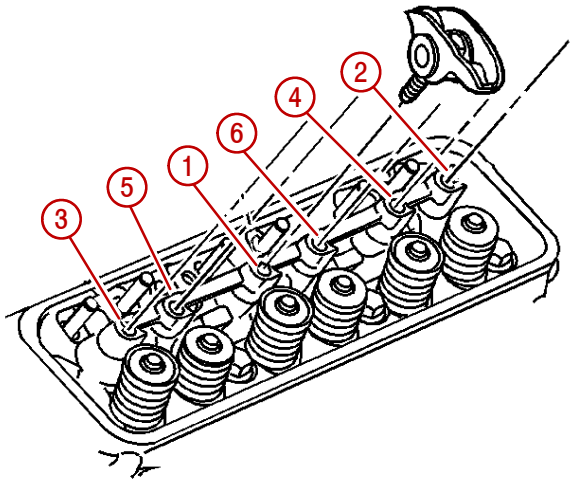
4. Lubricate the rocker arm and rocker arm ball contact surfaces.
5. Lubricate the threads of the valve rocker arm studs.




78232

**a** - Contact Surfaces
**b** - Threads

6. Install the rocker arm assemblies in their original locations.
   a. Finger tighten the bolts in the order shown.



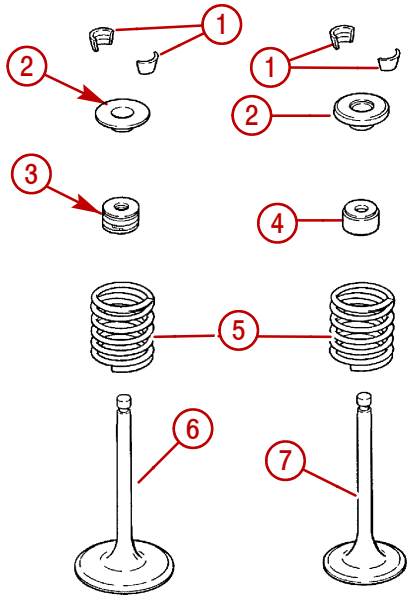

78242

| Description | | Where Used | Part Number |
|---|---|---|---|
| A | Johnson EP Lube | Valve pushrods, rocker arm and rocker arm ball contact surfaces | 92-801779 |
| B | 80W Gear Lube | Rocker arm ball stud | Obtain Locally |

7. Adjust valve clearance.

# Valve Stem Oil Seal / Valve Spring - Cylinder Head Installed

## Exploded View




78152

1 - Valve Locks
2 - Cap
3 - Intake Valve Stem Oil Seal
4 - Exhaust Valve Stem Oil Seal
5 - Spring
6 - Intake Valve
7 - Exhaust Valve

## Removal

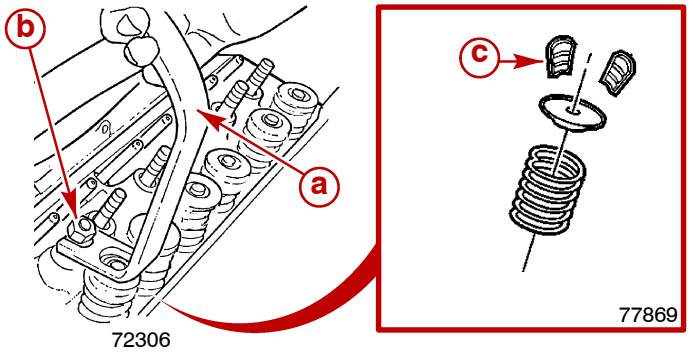
1. Remove valve cover.
2. Remove spark plug of affected cylinder.
3. Remove rocker arm assembly.

**IMPORTANT: Keep air pressure in cylinder while springs, caps and valve locks are removed or valves will fall into cylinder.**

4. Install air line adapter tool (J23590) in spark plug hole and apply compressed air to hold valves in place.

***NOTE:*** *If compressed air is not available, piston may be brought up to TDC and used to keep valves from falling out of valve guides.*

5. Using valve spring compressor under rocker arm nut as shown, compress valve spring and remove valve locks.

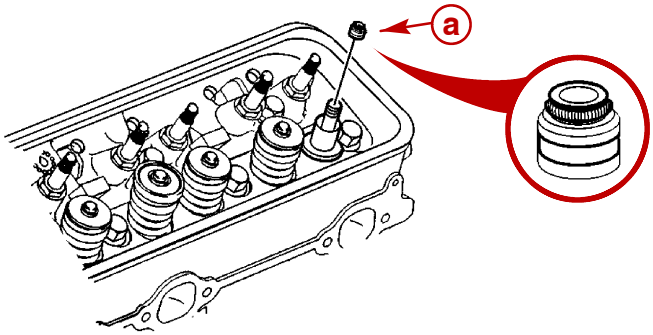



**a** - Valve Spring Compressor (J5892)
**b** - Rocker Arm Nut
**c** - Valve Locks

6. Slowly release valve spring compressor.
7. Remove valve spring cap and valve spring.

**IMPORTANT: If compressed air was not available, do not turn crankshaft while valve springs, retainers and locks are removed or valves will fall into cylinder.**

8. Remove and discard valve stem seal.




**Typical**

**a** - Valve Stem Seal

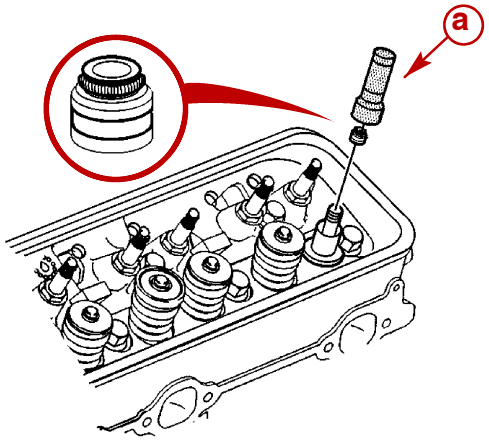
# Installation

**IMPORTANT: The intake valve oil stem seal is black. The exhaust valve stem seal material is either brown with a white paint stripe on the outer diameter or it is red with no paint stripe. Also, the letters “EX” are molded into the top of the exhaust valve stem seal.**

1. Select the appropriate intake or exhaust valve stem oil seal.
2. Coat the outside surface of the valve stem bore and all surfaces of the valve stem oil seal with clean engine oil.

| Description | Where Used | Part Number |
|---|---|---|
| Engine Oil | Valve stem bore and valve stem oil seal | Obtain Locally |

3. Install the valve stem seal onto the valve stem and push down until it is seated against the head.
4. Install special valve stem seal installer tool and press the valve stem seal until the tool contacts the spring seat.

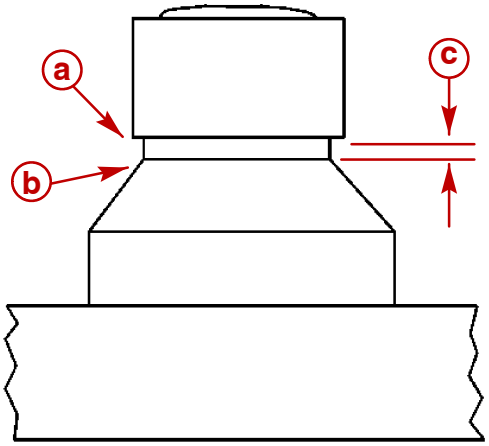



77867

**Typical**

**a** - Valve Stem Seal Installer Tool (J42073)

5. For all intake and exhaust valves, ensure that the installed height (the gap between the bottom edge of the valve stem oil seal and the cylinder head valve guide boss) is as specified.




77868

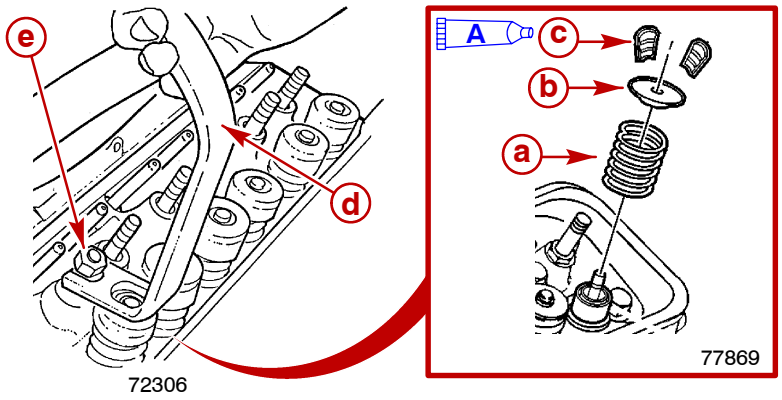
**a** - Bottom Of Valve Stem Oil Seal
**b** - Valve Guide Boss
**c** - Installed Height (Gap)

| Description | | 4.3 liter (262 cid) |
|---|---|---|
| Valve Stem Oil Seal | Installed Height [1] | 1 - 2 mm (0.0394 - 0.0787 in.) |

[1] Measured from top of valve guide bevel to bottom of oil stem seal.

6. Install the valve spring.
7. Place the valve spring cap on valve spring.
8. Temporarily install the rocker arm nut onto the corresponding stud.

9. Coat the valve stem locks with the lubricant to hold them in place.
10. While compressing valve spring with valve spring compressor, install the valve stem locks.
11. Ensure that the valve stem locks are seated properly in the groove of the valve stem.
12. Slowly release valve spring compressor and remove the rocker arm nut.




**a** - Valve Spring
**b** - Cap
**c** - Valve Stem Locks
**d** - Valve Spring Compressor (J5892)
**e** - Nut

| Description | | Where Used | Part Number |
|---|---|---|---|
| A | Needle Bearing Assembly Lubricant | Valve stem locks | 92-082868A1 |

13. Install pushrods and rocker arm assemblies. Torque the rocker arm bolts.

| Description | Nm | lb-in. | lb-ft |
|---|---|---|---|
| Rocker Arm Bolts | 30 | | 22 |

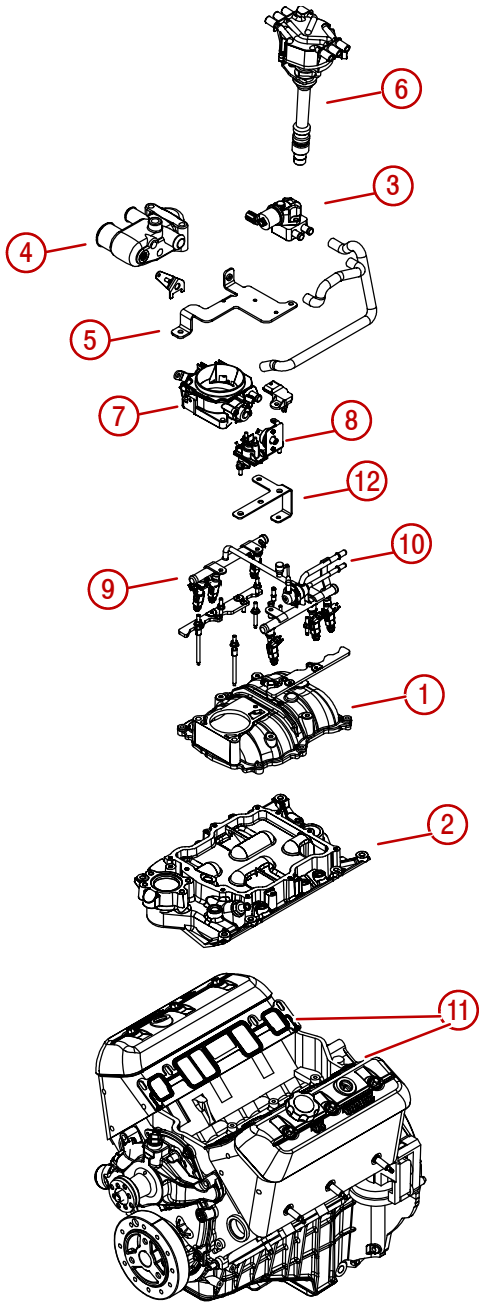
14. Remove the airline adapter tool (J23590).
15. Adjust valves as outlined under Valve Adjustment.
16. Install valve cover.
17. Install and torque spark plugs.

| Description | | Nm | lb-in. | lb-ft |
|---|---|---|---|---|
| Spark Plug | | | | |
| | Initial Installation (New Cylinder Head) | 30 | | 22 |
| | All Subsequent Installations | 15 | | 11 |

# Intake Manifold Assembly

***NOTE:*** *The upper and lower intake manifold parts may be removed as an assembly. Unless service is required, it is not necessary to remove individual intake manifold components other than as outlined. Refer to SECTION 5 for disassembly, cleaning, inspection and reassembly of individual intake manifold components.*

## Exploded View




78088

**1** - Upper Intake Manifold
**2** - Lower Intake Manifold
**3** - IAC
**4** - Thermostat Housing
**5** - IAC Bracket
**6** - Distributor
**7** - Throttle Body
**8** - Circuit Breaker
**9** - Fuel Rail
**10** - Fuel Line Connection
**11** - Intake Manifold Gasket
**12** - Circuit Breaker Bracket

## Removal

1. Drain engine seawater and closed cooling systems.
2. Disconnect hoses from thermostat housing.
3. Disconnect electrical leads interfering with removal.
4. Disconnect crankcase ventilation hoses from valve covers.
5. Disconnect throttle cable.

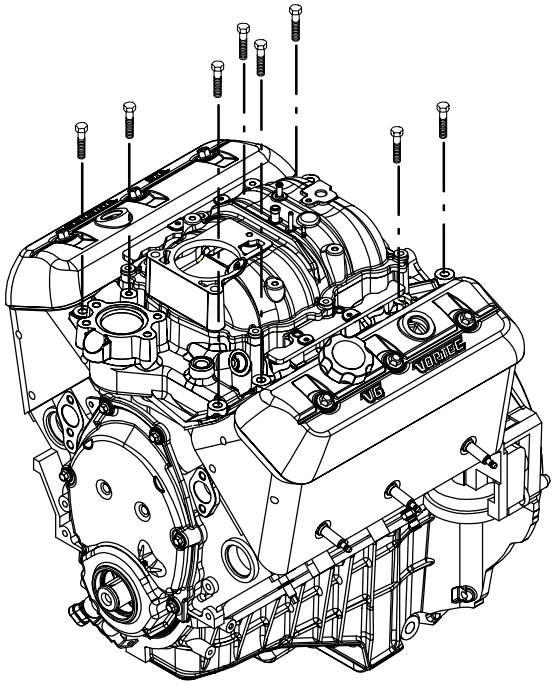
**⚠ CAUTION**

**Avoid fuel system damage. Do not allow dirt or debris to enter the fuel system. Seal open ends of fuel lines and fuel system.**

6. Using fuel line removal tool, disconnect fuel line.
7. Remove the ignition coil wire from the ignition coil and distributor cap.

**IMPORTANT: Do NOT engage starter after distributor has been removed.**

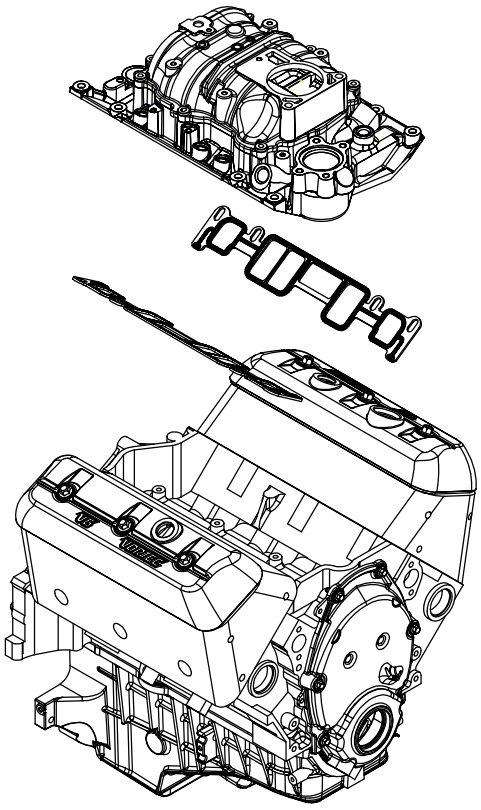
8. Remove the distributor clamp bolt.
9. Remove the distributor and the distributor clamp.
10. Remove the distributor gasket and discard.
11. Disconnect and remove items that interfere with removal of intake manifold assembly.
12. Remove lower intake manifold bolts.




78172

**IMPORTANT: It may be necessary to pry intake manifold away from cylinder heads and block, in next step. Use extreme care to prevent damage to sealing surfaces.**

13. Remove intake manifold assembly.



78262

14. Remove and discard the lower intake manifold gaskets.

***NOTE:*** *If part of the intake manifold assembly requires replacement, disassemble and transfer all remaining parts to new intake manifold component. Refer to SECTION 5.*

## Cleaning

**IMPORTANT: When cleaning cylinder head mating surface, do not allow gasket material to enter engine crankcase or intake ports.**

1. Clean gasket material from all mating surfaces.
2. Clean varnish buildup and other contaminants from intake passages.
3. Put on safety glasses. Clean bolt holes in cylinder head and dry with compressed air.

## Inspection

1. Inspect intake manifold assembly for cracks or scratches.
2. Ensure all machined mating surfaces are clean and free of all marks and deep scratches.

# Upper And Lower Intake Manifolds

Refer to SECTION 5, for disassembly, cleaning, inspection and reassembly of the individual components.

## Installation

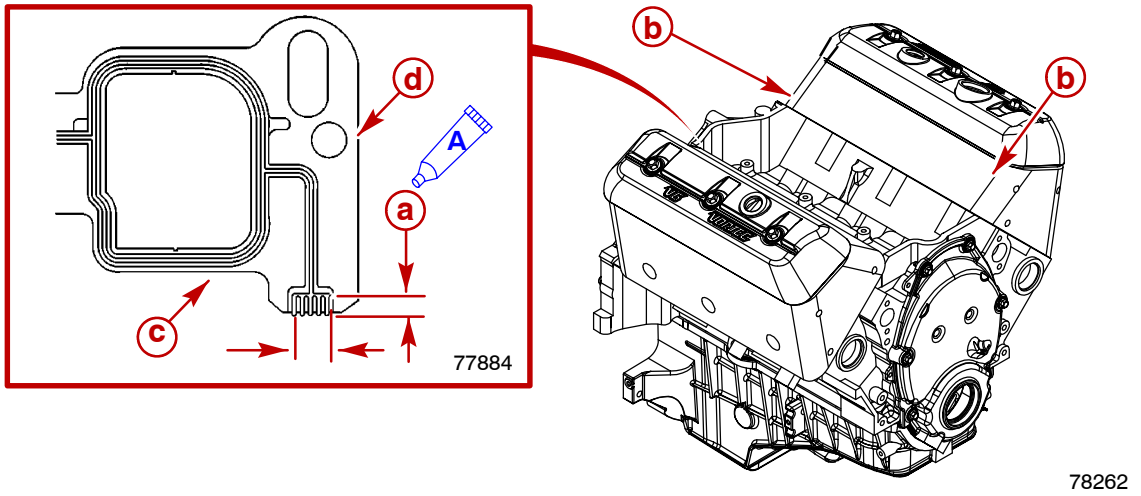
**⚠ CAUTION**

**Excessive amounts of adhesive or sealer on gaskets or component surfaces may cause improper sealing resulting in intake manifold air or fluid leaks. Do not apply excessive amounts of adhesive or sealer.**

1. Apply a 4 mm (5/32 in.) bead of adhesive at each end of the lower intake manifold gasket on the cylinder head side. Do NOT get sealer into oil sending unit hole.

***NOTE:*** *For proper adhesion, the lower intake manifold gasket must be installed while the adhesive is still wet.*

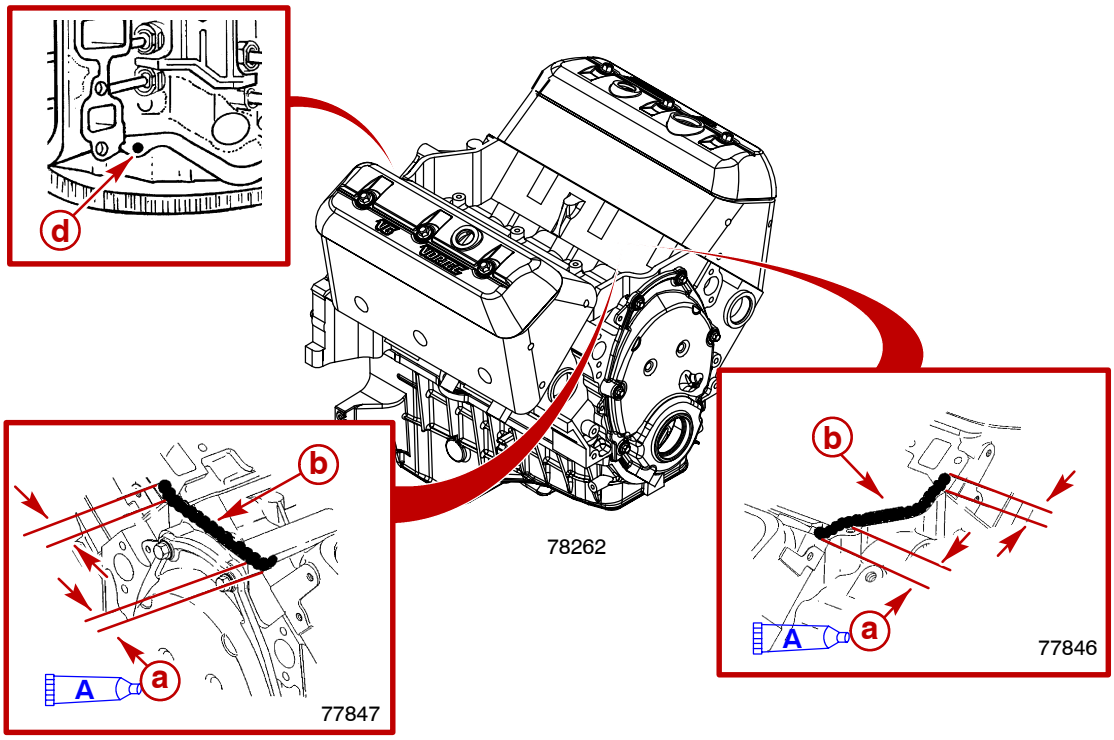
2. Align lower intake manifold gaskets with locator pins. Install lower intake manifold gaskets onto the cylinder heads.




**a** - Area Of Adhesive
**b** - Locator Pin
**c** - Gasket
**d** - Locator Pin Hole

| Description | | Where Used | Part Number |
|---|---|---|---|
| A | Ultra-Black Loctite 5900 | Lower intake manifold gaskets | 92-809826 |

3. Apply a 5 mm (13/64 in.) wide bead of adhesive to front and rear of engine block as shown. Extend adhesive bead 13 mm (1/2 in.) up on intake gaskets.




**a** - Bead Of Adhesive
**b** - Front Top Of Engine Block
**c** - Rear Top Of Engine Block
**d** - Hole

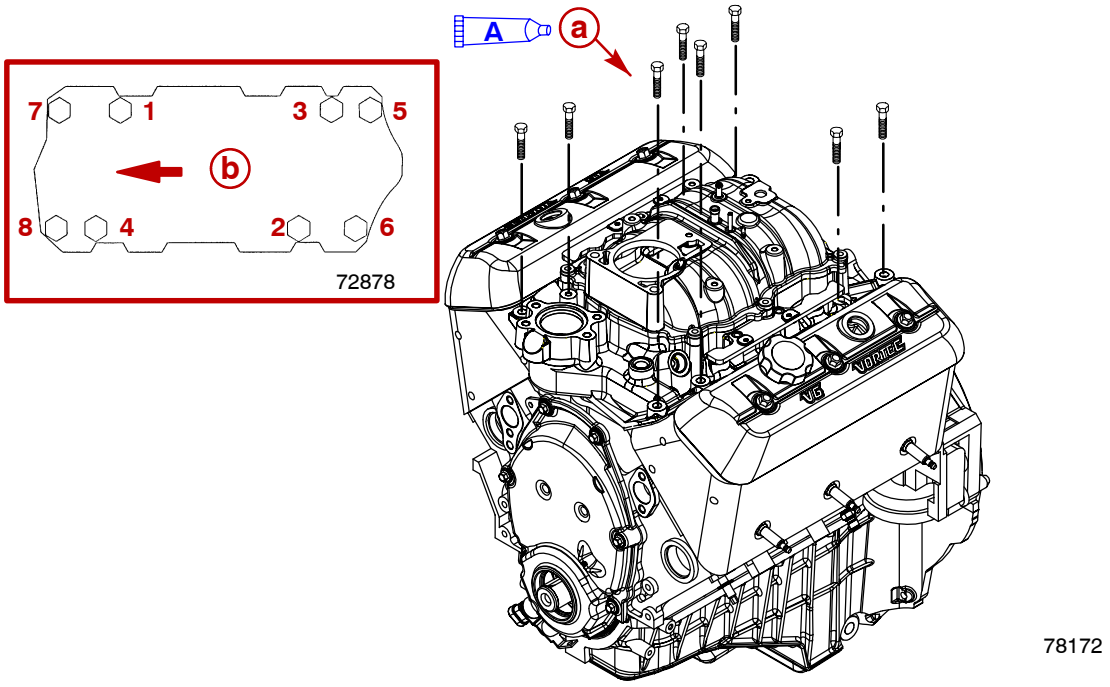
| Description | | Where Used | Part Number |
|---|---|---|---|
| A | Ultra-Black Loctite 5900 | Engine block at the lower intake manifold sealing surfaces | 92-809826 |

4. Coat threads of the lower intake manifold bolts with sealant.
5. Carefully install lower intake manifold assembly onto engine block.

**⚠ CAUTION**

**Avoid engine damage. Crankshaft bearing bore alignment may become distorted resulting in damage to the crankshaft bearings if intake manifold fastener tightening sequence and torque are done improperly. Always torque the bolts in sequence to the specified amount in each of the three passes required.**

6. Torque lower intake manifold bolts in sequence and passes indicated.




**a** - Intake Manifold Bolts
**b** - Front

| Description | | Where Used | Part Number |
|---|---|---|---|
| A | Loctite 242 | Lower intake manifold bolt | 92-809821 |

| Description | | Nm | lb-in. | lb-ft |
|---|---|---|---|---|
| Lower Intake Manifold Bolt (Each Pass In Sequence) | | | | |
| | First Pass | 3 | 27 | |
| | Second Pass | 12 | 106 | |
| | Final Pass | 15 | 132 | |

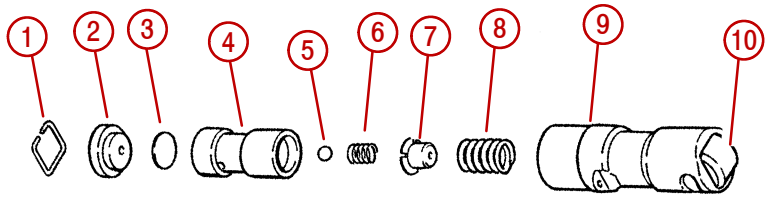
7. Connect all ignition and electrical leads.
8. Connect hoses to thermostat housing.
9. Install fuel line.
10. Connect crankcase ventilation hoses.
11. Install the distributor.

| Description | Nm | lb-in. | lb-ft |
|---|---|---|---|
| Distributor Hold Down Clamp Bolt | 25 | | 18 |

12. Install the ignition coil wire.
13. Install other ignition components and reconnect wires.
14. Connect any items that were disconnected.
15. Refill closed cooling system, if equipped.

# Hydraulic Valve Lifters

## Exploded View




72031

**Valve Lifter**

**1** - Pushrod Seat Retainer Clip
**2** - Pushrod Seat
**3** - Metering Valve
**4** - Plunger
**5** - Check Ball
**6** - Check Ball Spring
**7** - Check Ball Retainer
**8** - Plunger Spring
**9** - Lifter Body
**10** - Roller

## Special Information

Hydraulic valve lifters require little attention. These lifters are extremely simple in design. Normally, readjustments are not necessary and servicing requires only that care and cleanliness be exercised in the handling of parts.

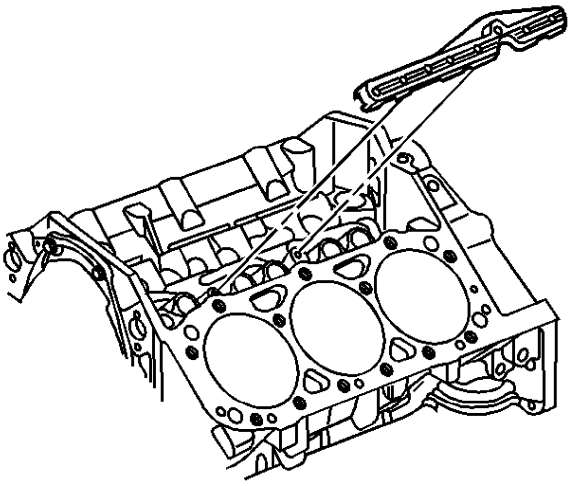
Refer to SECTION 1C for troubleshooting information such as locating a noisy lifter.

## Removal

1. Drain seawater and closed cooling systems.
2. Remove valve covers.

**IMPORTANT: Keep rocker arm assembly, valve pushrod and hydraulic valve lifter from each valve together as a matched set. Mark and organize parts so that they can be installed in the same location later.**

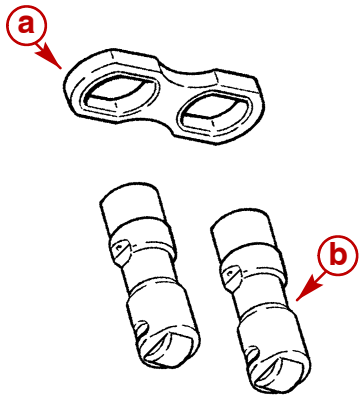
3. Remove rocker arm assemblies and pushrods. Keep parts in matched sets.
4. Remove intake manifold.
5. Remove lifter guide retainer.



78206

**IMPORTANT: Store the valve lifters in the upright position to prevent oil loss.**

6. Remove lifter guides and lifters. Use of the Valve Lifter Remover (J3049-A) may simplify removal. Store lifters in the upright position in order of removal.




72340

**a -** Lifter Guide
**b -** Lifter

## Cleaning

1. Put on safety glasses.
2. Except for the valve lifters, clean the parts with cleaning solvent.
3. Dry parts with compressed air.
4. While holding upright, wipe the valve lifters with a clean, oil saturated, lint free cloth. Store lifters in the upright position.

## Inspection

1. Ensure that the lifter seat retainer clip is not broken or damaged.
2. Inspect pushrod seat. If seat is scuffed or worn, inspect pushrod.
3. Inspect outer lifter body wall. If wall is scuffed or worn, inspect engine block lifter bore.
4. Inspect the roller of lifter. If roller is scuffed or worn, inspect camshaft lobe.
5. Ensure oil hole is unobstructed.
6. Inspect all parts carefully. If any are damaged or worn, the entire lifter assembly should be replaced.

72031

**Inspection Of Lifter**

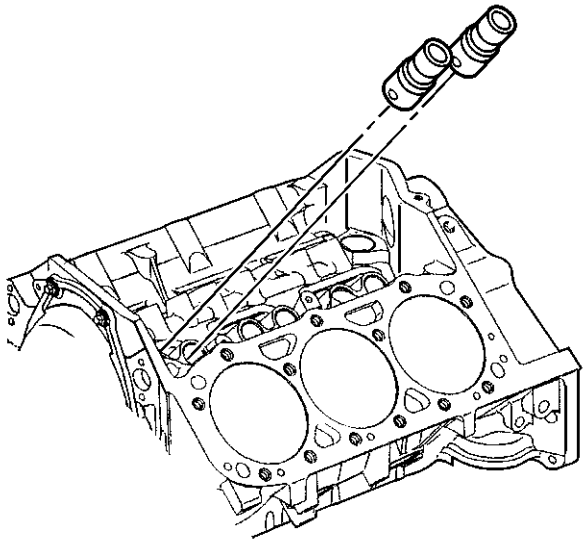
**a** - Seat Retainer Clip
**b** - Pushrod Seat
**c** - Lifter Body
**d** - Roller
**e** - Oil Hole

## Installation

**IMPORTANT: Do NOT install used valve lifters if a new camshaft has been installed.**

**IMPORTANT: Before installing valve lifters, coat the camshaft lobes and lifters with EP lube.**

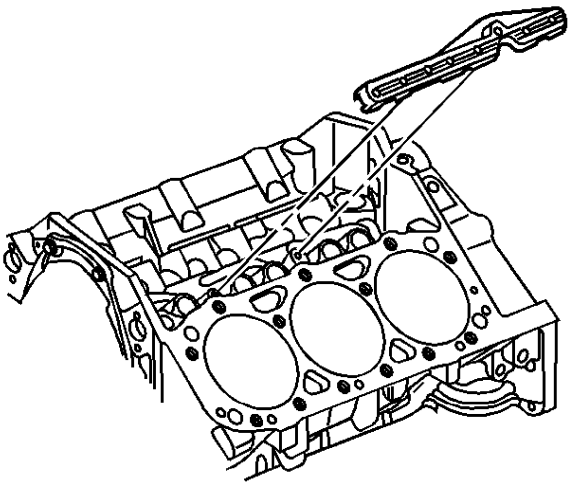
1. Lubricate and install valve lifters. Install lifters in original locations if being reused.



78207

| Description | Where Used | Part Number |
|---|---|---|
| Johnson EP Lube | Lifters, camshafts and camshafts lobes | 92-801779 |

2. Install lifter guides.
3. Install lifter guide retainer. Torque bolts.



78206

| Description | Nm | lb-in. | lb-ft |
|---|---|---|---|
| Valve Lifter Guide Retainer Bolt | 25 | | 19 |

4. Lubricate and install valve pushrods and rocker arm assemblies.

| Description | Where Used | Part Number |
|---|---|---|
| Engine Oil | Valve pushrods and rocker arm assemblies | Obtain Locally |

5. Adjust valve clearance.
6. Install intake manifold.
7. Install valve covers.
8. Change engine oil and filter.
9. Check for leaks when engine is started.

# Camshaft and Camshaft Bearings

**IMPORTANT: Camshaft bearings can be replaced while engine is disassembled for overhaul or without complete disassembly. To replace bearings without complete disassembly, remove camshaft and crankshaft, leaving cylinder heads attached and pistons in place. Disconnect and fasten connecting rods against sides of engine so that they will not interfere while replacing camshaft bearings.**

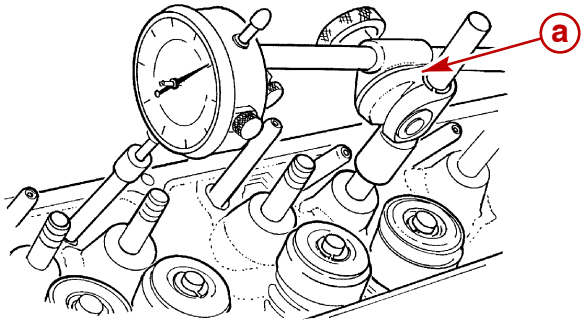
## Measuring Camshaft Lobe Lift

***NOTE:*** *Procedure is similar to checking valve timing. If improper valve operation is indicated, measure lift of each pushrod in consecutive order and record readings.*

1. Remove valve covers.

**IMPORTANT: Keep rocker arm assembly from each valve together as a matched set. Mark and organize parts so that they can be installed in the same location later.**

2. Remove rocker arm assemblies. Keep in matched sets.
3. Position indicator with ball socket adapter tool on valve pushrod. Ensure that pushrod is in lifter socket.




72380

**a** - Ball Socket Adapter Tool (J8520-1)

4. Rotate crankshaft balancer slowly in direction of engine rotation until lifter is on the heel of the cam lobe. At this point, the pushrod will be in its lowest position.
5. Set dial indicator on zero, then rotate crankshaft balancer slowly until pushrod is in fully raised position.
6. Compare total lift, recorded from dial indicator, to specification.

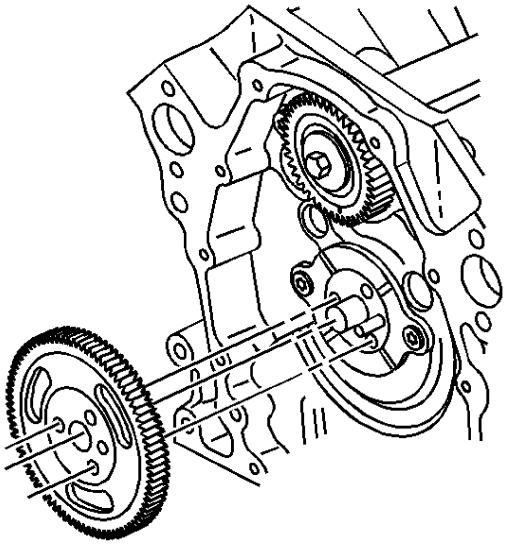
| **Description** | | **4.3 liter (262 cid)** |
|---|---|---|
| Valve Lift | Intake | 10.527 mm (0.4140 in.) |
| | Exhaust | 10.879 mm (0.4280 in.) |

7. Continue to rotate engine until indicator reads zero. This will ensure accuracy of original indicator reading.
8. Replace the camshaft if valve lift is not within specifications.
9. If camshaft readings for all lobes are within specifications, remove dial indicator assembly.
10. Install rocker arm assemblies.
11. Adjust valve clearance.
12. Install valve covers.
13. Check for leaks when engine is started.

# Removal

## BALANCE SHAFT

1. Remove the balance shaft drive gear.

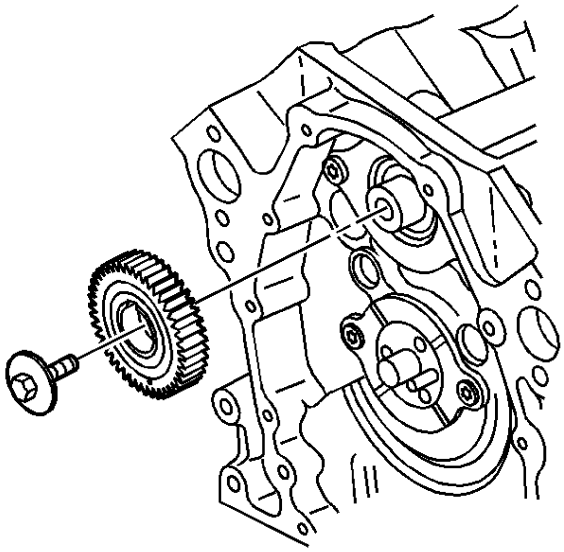


78252

**IMPORTANT: The balance shaft drive and balance shaft driven gears are serviced as a set. The set includes the balance shaft driven gear bolt.**

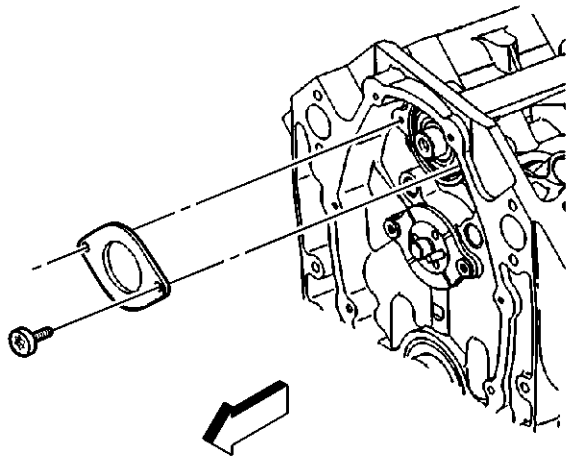
2. Remove the balance shaft driven gear bolt from the balance shaft.
   a. Place a wrench near the balance shaft front bearing to hold the balance shaft.
   b. Remove the balance shaft bolt.
   c. Remove the wrench.
3. Remove the balance shaft driven gear from the balance shaft.

78244



4. Remove the bolts and the balance shaft retainer.

78202



**IMPORTANT: The balance shaft and the balance shaft front bearing are serviced only as a package. Do not remove the balance shaft front bearing from the balance shaft.**

5. Use a soft-faced hammer in order to remove the balance shaft from the engine block.

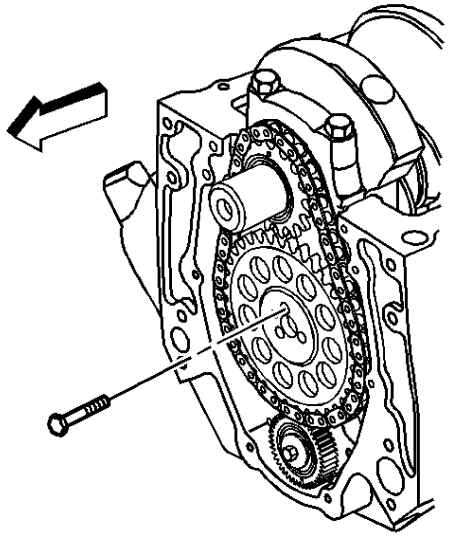
## BALANCE SHAFT BEARING

1. Put on safety glasses.
2. Install the Bushing/Bearing Remover (J26941) legs behind the balance shaft rear bearing and secure.
3. Install the short threaded end of J38834-1 through the balance shaft bore in the front of the engine block.
4. Install J38834-1 into the Bushing/Bearing Remover.
5. Slide the J38834-2 onto J38834-1 and into the balance shaft bore.
6. Install the J38834 bearing, washer and nut onto J38834-1.
7. Hold J38834-1 with a wrench and rotate the J38834 nut clockwise until the balance shaft rear bearing is removed.
8. Remove the Bushing/Bearing Remover from the balance shaft rear bearing.
9. Discard the balance shaft rear bearing.

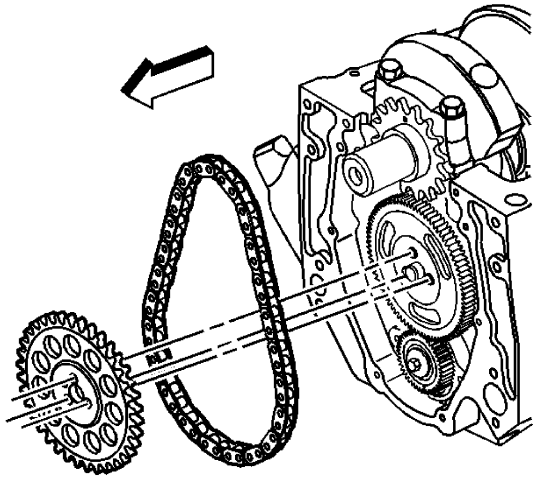
## CAMSHAFT

1. Remove all components from the front of the engine.
2. Remove valve lifters.
3. Remove crankcase front cover.

4. Remove camshaft sprocket and timing chain.

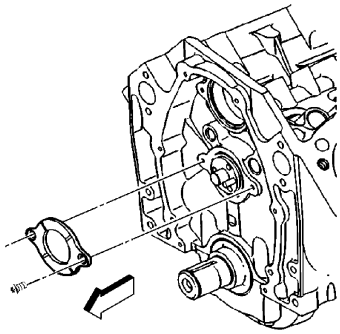


78227



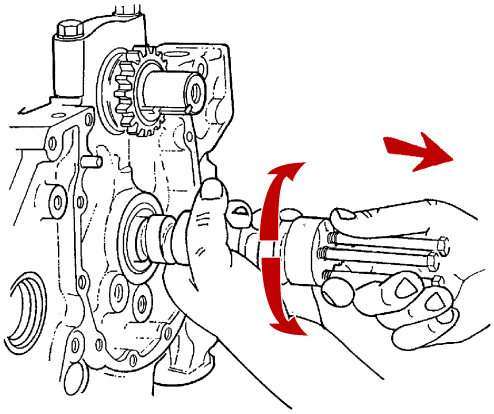
78228

5. Remove camshaft thrust plate.



78201

6. Install three 5/16-18 x 5 in. (127 mm) long bolts in camshaft bolt holes.
7. Carefully rotate and remove camshaft as shown.



72381

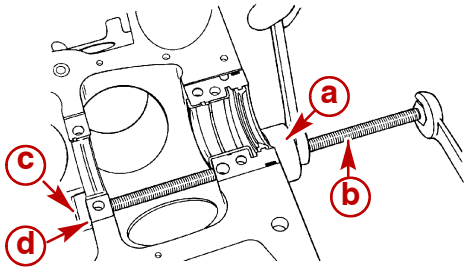
**Removing Camshaft**

## CAMSHAFT BEARINGS

1. With camshaft and crankshaft removed, drive camshaft rear plug from engine block.

***NOTE:*** *This procedure is based on removal of bearings from center of engine first, thus requiring a minimum amount of effort to remove all bearings.*

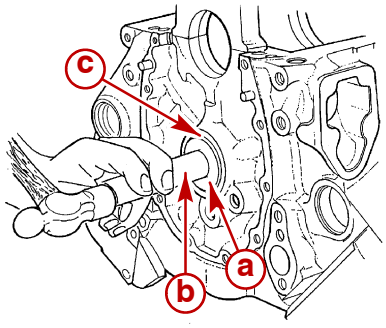
2. Install nut and thrust washer to the end of the threads on the Camshaft Bearing Service Kit (J33049).
3. Position index pilot in front camshaft bearing.
4. Install puller screw through the index pilot.
5. Install driver with shoulder toward bearing. Ensure that a sufficient amount of threads are engaged.
6. Use one wrench to hold puller screw, while turning nut with second wrench.
7. Pull bearing from bore.
8. Remove tool and bearing from puller screw.
9. Remove remaining center bearing.




72383

**a** - Index Pilot
**b** - Puller Screw
**c** - Driver
**d** - Bearing

10. Assemble driver on driver handle. Drive front and rear camshaft bearings toward center of engine block and remove bearings.




72384

**a** - Driver
**b** - Driver Handle
**c** - Bearing

## Cleaning

### BALANCE SHAFT

1. Put on safety glasses.
2. Clean balance shaft, balance shaft retainer, balance shaft rear bearing and balance shaft gears with cleaning solvent.
3. Dry all parts with compressed air.

### CAMSHAFT

1. Put on safety glasses.
2. Clean camshaft thrust plate with cleaning solvent.
3. Clean camshaft with cleaning solvent.
4. Dry parts with compressed air.

### CAMSHAFT BEARINGS

1. Put on safety glasses.
2. Clean bearings in cleaning solvent.
3. Clean camshaft bearing bores in engine block with solvent.
4. Ensure that grooves and drilled oil passages are clean.
5. Blow bores and passages clean with compressed air.
6. Dry parts with compressed air.

# Inspection

## BALANCE SHAFT

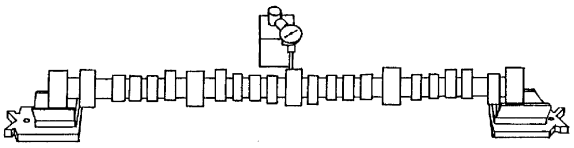
7. Inspect the front bearing for damage and smoothness of operation.
8. Inspect the rear bearing for damage.
9. Inspect the balance shaft, retainer and gears for wear or damage.
10. Inspect the balance shaft journals for wear or damage.

## CAMSHAFT

1. Inspect camshaft thrust plate for damage. Replace if damaged or worn.
2. Inspect the camshaft for worn, scored or damaged bearing journals or lobes.
3. Inspect the camshaft for bolt hole threads.
4. Inspect the camshaft sprocket locator pin.
5. Measure camshaft bearing journals with a micrometer. If journals are not within specifications, camshaft should be replaced.

| Description | 4.3 liter (262 cid) |
|---|---|
| Journal Diameter | 47.440-47.490 mm (1.8677-1.8697 in.) |
| Journal Out Of Round | 0.025 mm (0.0010 in.) Maximum |

6. Measure for a bent camshaft or excessive camshaft runout with V-blocks and dial indicator. If runout exceeds specified amount, camshaft should be replaced.



72382

**Checking Camshaft Runout**

| Description | 4.3 liter (262 cid) |
|---|---|
| Camshaft Runout | 0.065 mm (0.0026 in.) Maximum |

## BEARINGS

1. Inspect camshaft bearings for excessive wear or scoring. If any camshaft bearing is excessively worn or scored, replace all the camshaft bearings.
2. Inspect the camshaft bearings for correct fit into the engine block camshaft bearing bores. The camshaft bearings have an interference fit to the engine block camshaft bearing bores and must not be loose in the bores.

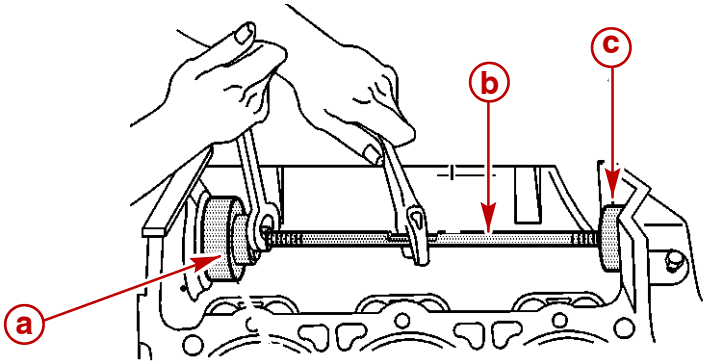
# Installation

## BALANCE SHAFT BEARING

1. Install J 38834-3 from the Balance Shaft Service Kit (J38834) onto the short threaded end of the rod (J 38834-1).
2. Install the nut, the washer and the bearing from the Balance Shaft Service Kit (J38834) onto the long threaded end of the rod (J 38834-1).
3. Install J 38834-2 from the Balance Shaft Service Kit (J38834) onto the rod (J 38834-1) so that the smaller diameter of J38834-2 will be facing the front of the engine block.
4. Install J 38834-2 on the inside of the balance shaft front bearing bore.
5. Lubricate the new balance shaft rear bearing.

| Description | Where Used | Part Number |
|---|---|---|
| Engine Oil | Balance shaft bearings | Obtain Locally |

6. Install the balance shaft rear bearing onto J 38834-2.
7. Align the bearing for installation.
8. Using a wrench, secure the rod (J 38834-1).
9. Rotate the nut until the balance shaft bearing is completely pushed into the balance shaft rear bearing bore.




78218

**a** - Balance Shaft Service Kit (J 38834-2)
**b** - Rod (J 38834-1)
**c** - Balance Shaft Service Kit (J 38834-3)

10. Remove the tool.

## CAMSHAFT BEARINGS

**IMPORTANT: Front and rear bearings must be installed last as index pilot will not fit into bearing bores if front and rear bearings are installed.**

1. Lubricate outer surface of new camshaft bearings with lubricant to ease installation.

| Description | Where Used | Part Number |
|---|---|---|
| Engine Oil | Camshaft bearings | Obtain Locally |

2. Before installation, ensure camshaft bearings are positioned (indexed) as indicated:

**IMPORTANT: All camshaft bearings are not the same. Be sure to install bearings in proper locations (Indicated by bearing manufacturer) and positioned correctly.**

   a. Position the front bearing so that the oil hole is at the 9 o'clock position in the block.

   b. Position the intermediate and center bearings so that the oil holes are at the 3 o'clock and 9 o'clock position (toward left side of block and at a position even with bottom of cylinder bore).

   c. Position the rear bearing so that the oil hole is at the 3 o'clock position.

3. Install the front and rear camshaft bearings as follows:

   a. Install appropriate size removal and installation tool on drive handle.

   b. Index rear bearing and drive it into position with tool.

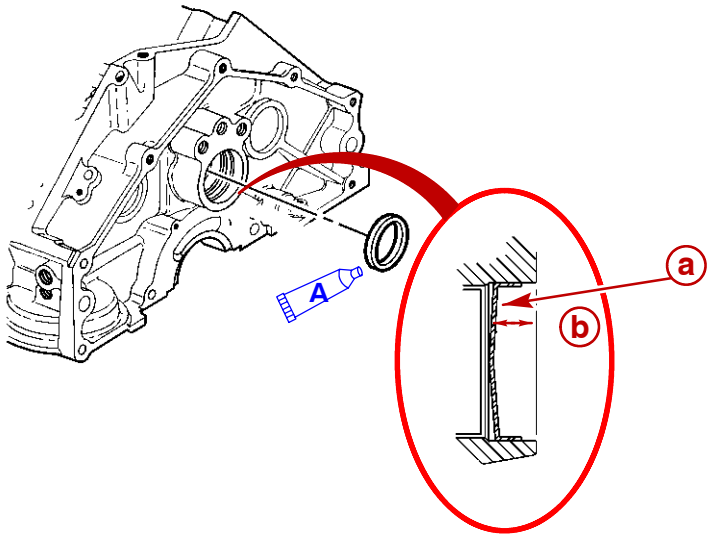
   c. Index front bearing and drive it into position with tool.

   d. Ensure bearings are positioned correctly.

   e. Coat outer diameter of a new camshaft rear bearing hole expansion cup plug with sealant.

   f. Install new camshaft rear bearing hole expansion plug.

**IMPORTANT: Camshaft rear bearing hole plug must be installed 8.8 mm (0.3465 in.) deep and must be parallel with rear surface of engine block.**




**a** - Camshaft Rear Bearing Hole Expansion Cup Plug
**b** - Measurement - 8.8 mm (0.3465 in.)

| Description | | Where Used | Part Number |
|---|---|---|---|
| A | Loctite 565 PST | Expansion cup plug (camshaft rear bearing hole) | Obtain Locally |

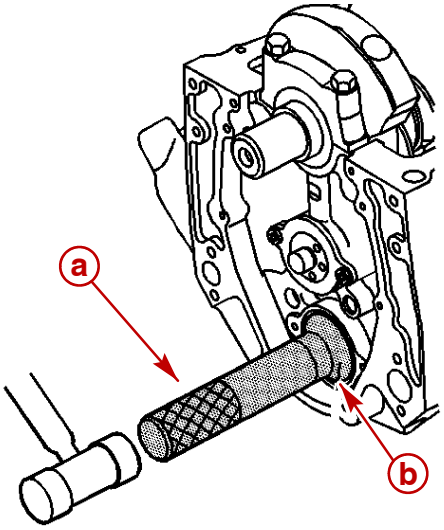
4. Install intermediate and center camshaft bearings as follows:
   a. Install nut and thrust washer onto puller screw.
   b. Position pilot in front camshaft bearing bore and insert screw through pilot.
   c. Index center camshaft bearing.
   d. Position appropriate size removal and installation tool in bearing and thread puller screw into tool. Ensure that at least 13 mm (1/2 in.) of threads are engaged.
   e. Using two wrenches, hold puller screw and turn nut until bearing has been pulled into position.
   f. Remove the removal and installation tool and ensure that oil holes in bearing are positioned correctly.
   g. Repeat steps a. –f. to install the intermediate bearings. Ensure bearings are indexed correctly. Position pilot in rear camshaft bearing bore to install rear intermediate bearing.

## BALANCE SHAFT

1. Lubricate the balance shaft front bearing.

| Description | Where Used | Part Number |
|---|---|---|
| Engine Oil | Balance shaft front bearing | Obtain Locally |

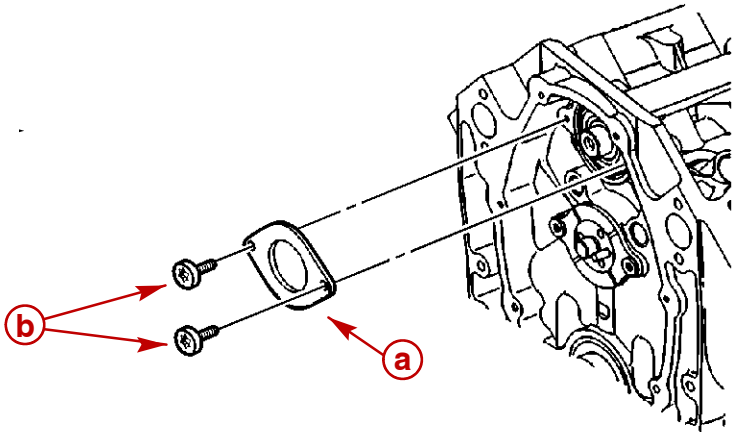
2. Using the balance shaft installer and the driver handle install the balance shaft.




78245

**a** - Driver Handle
**b** - Balance Shaft Installer

3. Install the balance shaft retainer and bolts.
4. Torque the bolts.



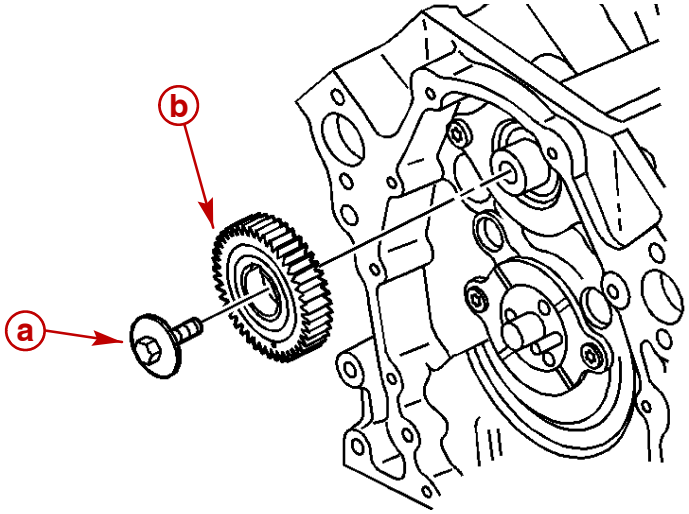

78202

**a** - Balance Shaft Retainer
**b** - Bolts

| Description | Nm | lb-in. | lb-ft |
|---|---|---|---|
| Balance Shaft Retainer Bolts | 12 | 106 | |

5. Install the balance shaft driven gear onto the balance shaft.

6. Apply adhesive to the threads of the balance shaft driven gear bolt.




78244

**a** - Balance Shaft Driven Gear Bolts
**b** - Driven Gear

| Description | Where Used | Part Number |
|---|---|---|
| Loctite 242 | Balance shaft driven gear bolt threads | 92-809821 |

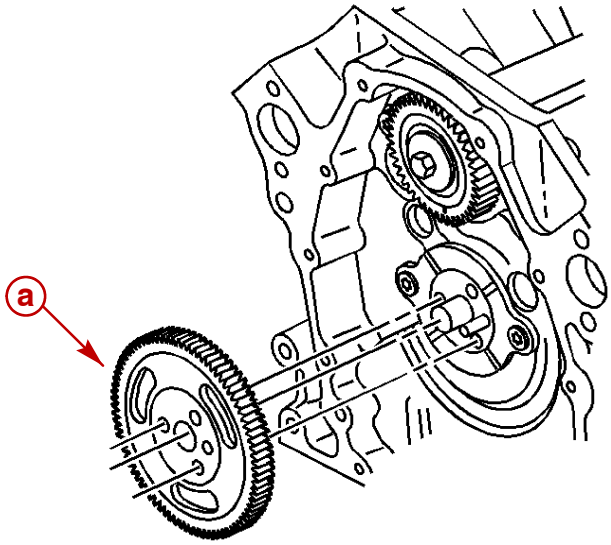
7. Install the balance shaft driven gear bolt, as follows:
   a. Secure the balance shaft with a wrench.
   b. Install and torque the balance shaft driven gear bolt.

| Description | | Nm | lb-in. | lb-ft |
|---|---|---|---|---|
| Balance Shaft Driven Gear Bolts | | | | |
| | First Pass | 20 | | 15 |
| | Final Pass | +35 degrees | | |

8. Remove the wrench from the balance shaft.
9. Rotate the balance by hand to ensure clearance between the balance shaft and the valve lifter pushrod guide.

***NOTE:*** *If the balance shaft does not rotate freely, ensure the retaining ring on the balance shaft front bearing is seated on the case.*

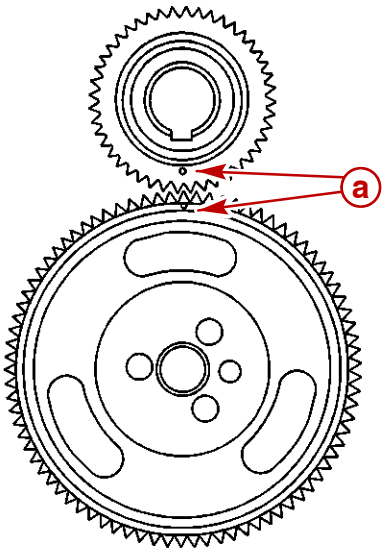
10. Install the balance shaft drive gear.




78252

**a** - Balance Shaft Drive Gear

11. Rotate the engine camshaft so that the timing mark on the balance shaft drive gear is in the 12 o'clock position.
12. Remove the balance shaft drive gear.
13. Rotate the balance shaft so that the timing mark on the balance shaft driven gear is in the 6 o'clock position.
14. Position the balance shaft drive gear onto the engine camshaft.
15. Ensure that the balance shaft drive gear and the balance shaft driven gear timing marks are aligned.




78246

**a** - Timing Marks

## CAMSHAFT

1. Install three 5/16-18 x 5 in. bolts in camshaft bolt holes.
2. Lubricate camshaft journals with engine oil and install camshaft. Be careful not to damage bearings.

| Description | Where Used | Part Number |
|---|---|---|
| Engine Oil | Camshaft journals | Obtain Locally |

3. Lubricate camshaft lobes with EP lube or equivalent.

| Description | Where Used | Part Number |
|---|---|---|
| Johnson EP Lube | Camshafts and camshafts lobes | 92-801779 |

4. Remove the three bolts in camshaft bolt holes.
5. Coat threads of camshaft thrust plate retainer bolts with adhesive.

| Description | Where Used | Part Number |
|---|---|---|
| Loctite 242 Threadlocker | Camshaft thrust plate retainer bolt | 92-809821 |

6. Install camshaft thrust plate retainer and bolts. Torque bolts.

| Description | Nm | lb-in. | lb-ft |
|---|---|---|---|
| Camshaft Thrust Plate (Retainer) Bolts | 12 | 106 | |

7. Install timing chain.
8. Install new crankcase front cover and gasket.
9. Install valve lifters.
10. Install rocker arm assemblies.
11. Adjust valve clearance.
12. Install valve covers.

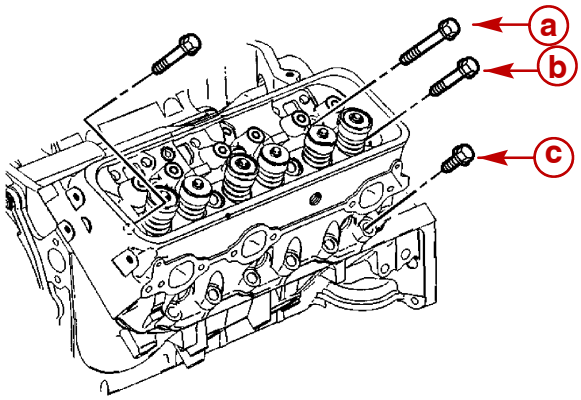
# Cylinder Head

## Removal

1. Drain seawater and closed cooling systems.
2. Remove exhaust elbows and manifolds.
3. Remove valve covers.
4. Remove intake manifold assembly.

**IMPORTANT: Keep rocker arm assembly, valve pushrod and hydraulic valve lifter from each valve together as a matched set. Mark and organize parts so that they can be reinstalled in the same location later.**

5. Remove rocker arm assemblies and pushrods. Keep in matched sets.
6. Remove any components attached to the cylinder head.
7. Remove spark plugs.
8. Remove cylinder head bolts.




78225

**a** - Long Bolts
**b** - Medium Bolts
**c** - Short Bolts

**⚠ CAUTION**

**The head gasket may be holding cylinder head to block. Use care when prying off cylinder heads. Do NOT damage gasket surfaces. Do NOT drop cylinder heads.**

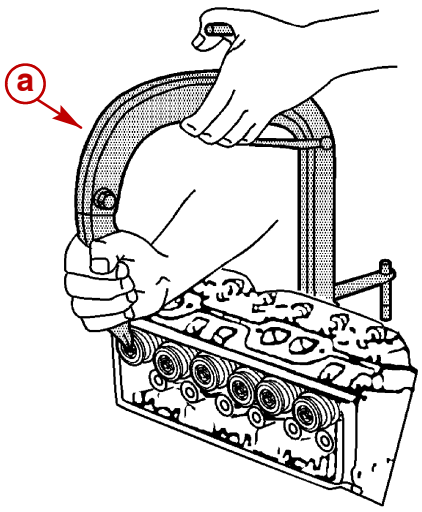
9. Remove cylinder head.
10. Place cylinder head on wooden blocks to prevent damage to gasket surfaces.

## Disassembly

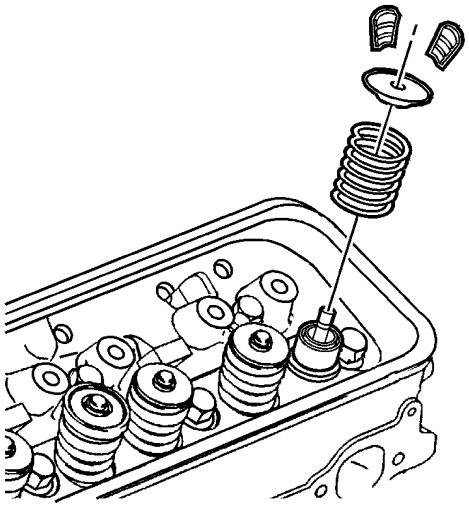
1. Using valve spring compressor, compress valve spring and remove valve locks. Slowly release tool.

**IMPORTANT: Keep components together as a matched set. Mark and organize parts so that they can be reinstalled in the same location later.**

2. Remove valve cap and spring.



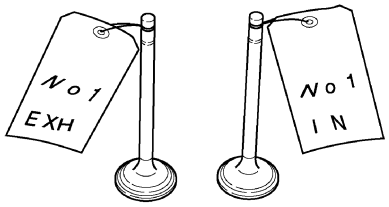

78234



78235

**a** - Valve Spring Compressor (J8062)

3. Remove valves from cylinder head.
4. Mark and organize components for installation in the same location later.




77175

5. Remove and discard valve stem oil seals.
6. Place cylinder head on wooden blocks to prevent damage to gasket surfaces.

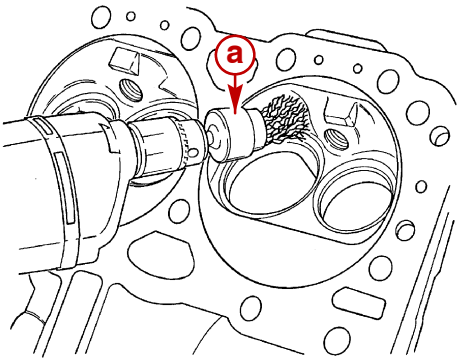
# Cleaning

## VALVE COMPONENTS

1. Put on safety glasses.
2. Clean the valve stem locks, valve spring caps and valve springs in cleaning solvent.
3. Clean carbon from valves using a wire wheel.
4. Clean the valves in cleaning solvent.
5. Dry parts with compressed air.

## CYLINDER HEAD

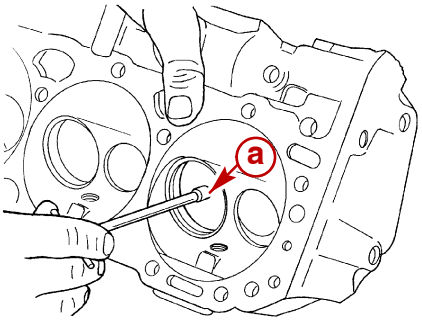
1. Put on safety glasses.
2. Clean gasket material and sealer from engine block and cylinder head sealing surfaces.
3. Clean all carbon from combustion chambers and valve ports using carbon remover brush.




72334

**a** - Carbon Remover Brush (J8089)

4. Thoroughly clean valve guides with valve guide cleaner.




72335

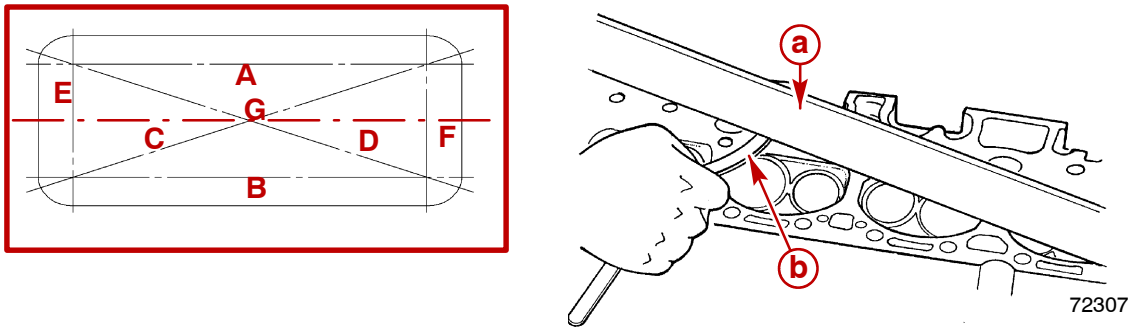
**a** - Valve Guide Cleaner (J8101)

5. Clean and dry the cylinder head.
6. Clean cylinder head bolt threads and engine block bolt hole threads to ensure that no dirt, old oil or coolant remain.
7. Dry parts with compressed air, including cylinder head bolt threads and engine block bolt hole threads.

# Inspection

## CYLINDER HEAD

1. Inspect sealing surfaces for burrs, scratches, deep nicks, erosion or other damage.
2. Inspect for cracks in exhaust ports, water jackets and combustion chambers (especially around spark plug holes and valve seats).
3. Replace heads if necessary.
4. Inspect for rusted, damaged or leaking core plugs. Replace plugs if necessary.
5. Inspect for corrosion around cooling passages.
6. Check flatness of cylinder head gasket surfaces, using a machinist's straight edge and feeler gauges as shown. Take measurements diagonally (C, D), across head both ways (A, B, E, F) and straight down center of head (G).




**Measuring Engine Block Deck Surface Flatness – All Decks Similarly Measured**

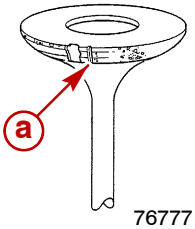
**a** - Straight Edge
**b** - Feeler Gauge

| Description | | 4.3 liter (262 cid) |
|---|---|---|
| Surface Flatness | At Exhaust Manifold Deck | 0.05 mm (0.0020 in.) |
| | At Engine Block Deck - Within An 152 mm (6.0 in.) Area | 0.10 mm (0.0039 in.) |
| | At Intake Manifold Deck | 0.10 mm (0.0039 in.) |
| | Intake Manifold Flatness | 0.10 mm (0.0039 in.) |

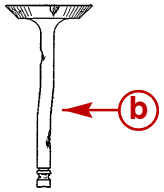
7. If measured value is greater than specified, the cylinder head must be repaired or replaced to provide proper alignment.

## VALVE

1. Inspect valves for burned heads, cracked or pitted faces or damaged stems.




76777

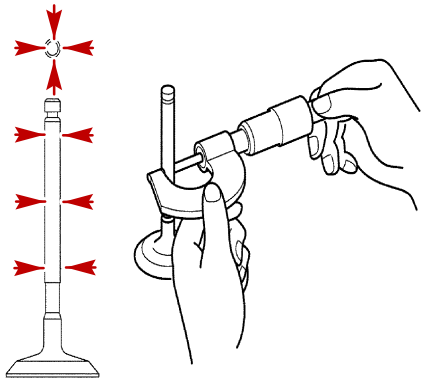



76776

**a** - Cracked, Pitted Face
**b** - Damaged Stems

**IMPORTANT: Excessive valve stem to bore clearance will cause excessive oil consumption and possibly broken valves. Insufficient clearance will result in noisy, binding valves.**

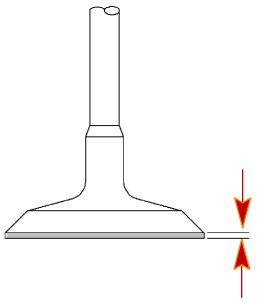
2. Measure valve stem diameter in three places.
3. If the measured value is less than specified limit, the valve must be replaced.



77196

| Description | | 4.3 liter (262 cid) |
|---|---|---|
| Production Stem Diameter | Intake | 8.661 - 8.679 mm (0.3410 - 0.3417 in.) |
| | Exhaust | |
| Service Stem Oversize Diameter | Exhaust Only | + 0.774 mm (+ 0.0305 in.) |

4. Measure valve head margin.
5. If measured value is less than specified, the valve must be replaced.

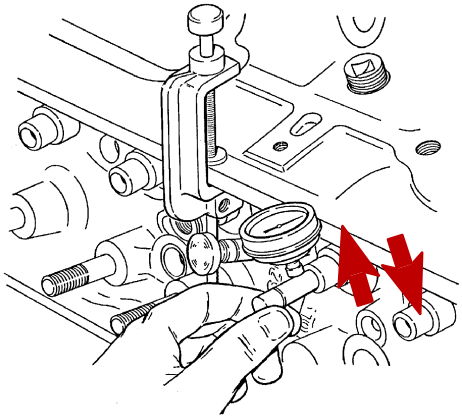


77197

| Description | | 4.3 liter (262 cid) |
|---|---|---|
| Margin After Surfacing | Intake | 0.79 mm (0.0311 in.) Minimum |

## VALVE STEM TO BORE CLEARANCE

1. Using a valve with specified stem diameter or a new valve, measure valve stem clearance.
   a. Attach a dial indicator to cylinder head. Position it against the valve stem and close to the valve guide.
   b. Holding valve head off the seat about 2 mm (1/16 in.), move valve stem side to side in the guide as shown. Compare stem clearance with specifications.



72336

**Measuring Stem Clearance**

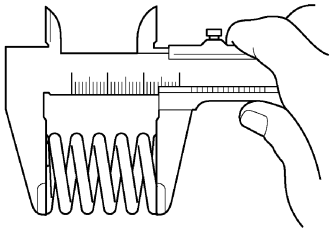
| Description | | 4.3 liter (262 cid) |
|---|---|---|
| Production | Intake | 0.025-0.069 mm (0.0010-0.0027 in.) |
| | Exhaust | 0.025-0.069 mm (0.0010-0.0027 in.) |
| Service | Intake | 0.025-0.094 mm (0.0010-0.0037 in.) |
| | Exhaust | 0.025-0.094 mm (0.0010-0.0037 in.) |

c. **If clearance exceeds specifications on exhaust valve and exhaust guide:** it will be necessary to ream valve guide and install a valve with an oversized stem. Refer to Repair - Valve Guide Bore.

d. **If clearance exceeds specifications on intake valve and intake guide:** it will be necessary to replace the cylinder head. Intake valves are NOT available with oversize stems.

## VALVE SPRINGS

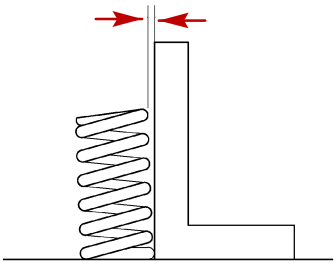
1. Use a vernier caliper to measure the valve spring free length. Replace spring if it is more or less than specified limit.



77198

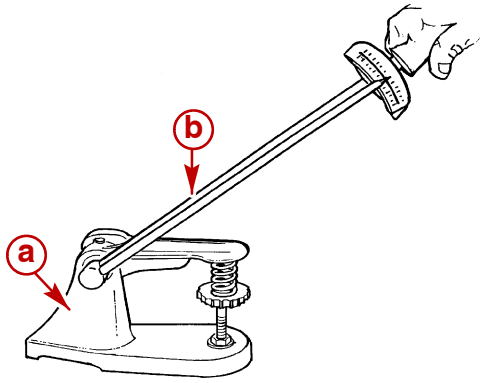
| Description | 4.3 liter (262 cid) |
|---|---|
| Free Length | 51.3 mm (2.02 in.) |

2. Measure the valve for squareness.



77199

3. Use a spring tester to measure the valve spring tension. Replace spring if measured value is less than specified limit.




72308

**a** - Valve Spring Tester (J9666)
**b** - Torque Wrench

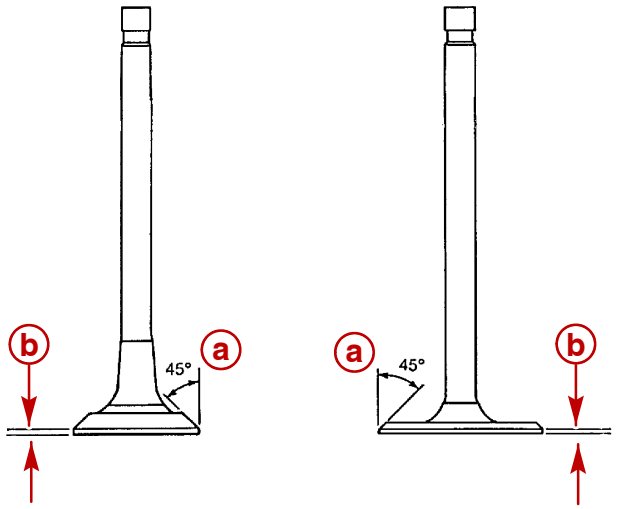
| Description | | 4.3 liter (262 cid) |
|---|---|---|
| Pressure | Valve Closed | 338-374 N (76-84 lb.) at 43.2 mm (1.7008 in.) |
| | Valve Open | 832-903 N (187-203 lb.) at 32.3 mm (1.2717 in.) |

# Repair

## VALVE RECONDITIONING

1. Recondition valve face to the proper angle if valve face is pitted or worn.
2. Measure valve margin. If valve margin is less than specified amount after reconditioning, replace the valve.

***NOTE:*** *Several different types of equipment are available for reconditioning valves. The manufacturer's recommendation should be carefully followed to attain proper results.*




**Exhaust** **Intake**

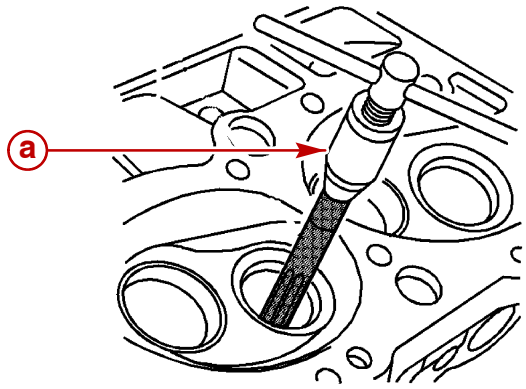
**a** - Face Angle
**b** - Margin

| Description | | 4.3 liter (262 cid) |
|---|---|---|
| Face Angle | Intake | 45 degrees |
| | Exhaust | 45 degrees |
| Margin After Surfacing | Intake | 0.79 mm (0.0311 in.) Minimum |

## VALVE GUIDE BORE

**IMPORTANT: Measure valve stem diameter of both the intake and exhaust valve, as valve stem diameter may or may not be the same for both valves.**

1. If exhaust valves with oversize valve stems are required, ream valve guide bores.




78236

**a -** Valve Guide Reamer (J5830-3)

| Description | | 4.3 liter (262 cid) |
|---|---|---|
| Production Stem Diameter | Intake | 8.661 - 8.679 mm (0.3410 - 0.3417 in.) |
| | Exhaust | |
| Service Stem Oversize Diameter | Exhaust Only | + 0.774 mm (+ 0.0305 in.) |

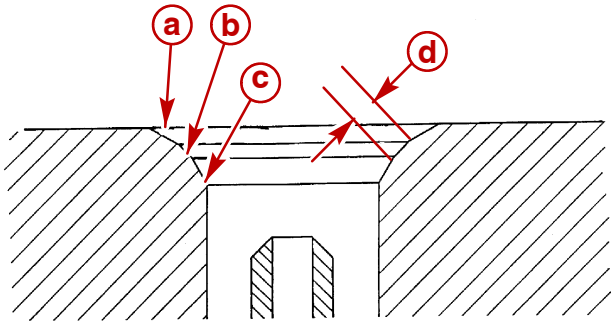
2. Remove the sharp corner created by reamer at top of valve guide.
3. Install valve with oversized stem.
4. Measure valve stem to bore clearance.

## VALVE SEAT

**IMPORTANT: Regardless of type of equipment, it is essential that valve guide bores be free from carbon or dirt to achieve proper centering of pilot in valve guide, ensuring concentricity when reconditioning valve seats.**

***NOTE:*** *Several different types of equipment are available for reconditioning valve seats. Equipment manufacturer's recommendations should be followed to attain proper results.*

5. Recondition valve seats if pitted or worn.



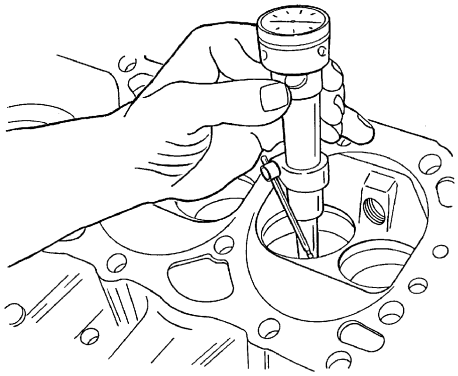

50668

**Typical 3 Angle Valve Seat**

- **a** - Top Correction Cut Angle
- **b** - Seat Angle
- **c** - Bottom Correction Cut Angle
- **d** - Seat Width

| Description | | 4.3 liter (262 cid) |
|---|---|---|
| Seat Angle | Intake and Exhaust | 46 degrees |
| Top Correction Cut Angle | | 30 degrees |
| Bottom Correction Cut Angle | | 60 degrees |
| Width | Intake | 1.016-1.651mm (0.040-0.065 in.) |
| | Exhaust | 1.65-2.489 mm (0.0650-0.0980 in.) |

6. Measure valve seat concentricity.
7. Recondition the seat if measured value exceeds specified limit.



72338

**Measuring Valve Seat Concentricity**

| Description | | 4.3 liter (262 cid) |
|---|---|---|
| Runout | Intake | 0.05 mm (0.0020 in.) Maximum |
| | Exhaust | |

## Reassembly

1. Lubricate valve, valve guide bores and valve stems with clean engine oil.

| Description | Where Used | Part Number |
|---|---|---|
| Engine Oil | Valve, valve guide bore and valve stem | Obtain Locally |

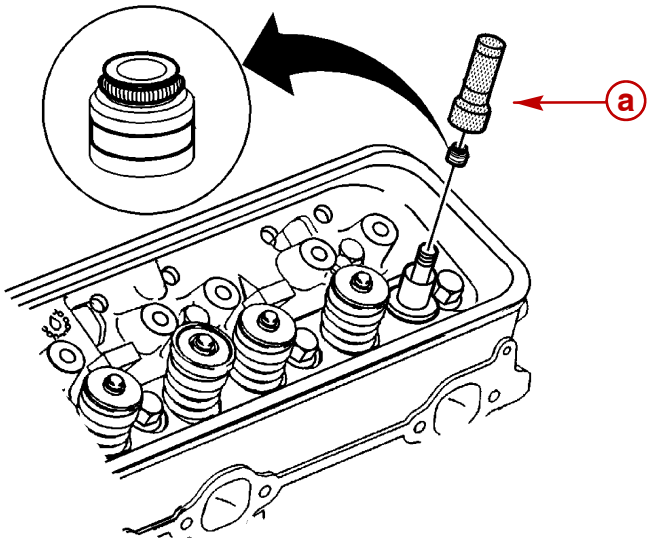
2. Install each valve in the port from which it was removed or for which it has been fitted.

**IMPORTANT: The intake valve oil stem seal material is black. The exhaust valve oil stem seal material is either brown with a white paint stripe on the outer diameter or it is red with no paint stripe. Also, the letters EX are molded into the top of the exhaust valve oil stem seal.**

3. Select the appropriate intake or exhaust valve stem oil seal.
4. Coat outside surfaces of valve guides and all surfaces of all the valve stem oil seals with clean engine oil.

| Description | Where Used | Part Number |
|---|---|---|
| Engine Oil | Valve guide and valve stem oil seal | Obtain Locally |

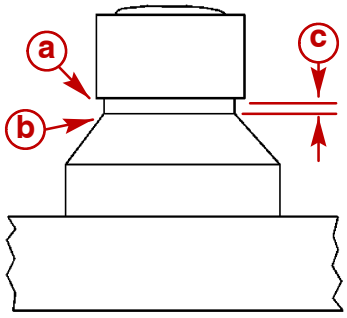
5. Install the valve guide seal onto the valve stem and push down until seated against the guide.
6. Install the valve stems with the Valve Stem Seal Installer.




78237

**a** - Valve Stem Seal Installer (J 42073)

7. Ensure that the valve stem seal is not pressed too far onto valve guide in the head. A specified gap should exist between the bottom edge of the valve stem oil seal and the cylinder head valve guide boss.




77868

**a** - Bottom Of Valve Stem Oil Seal
**b** - Valve Guide Boss
**c** - Installed Height (Gap)

| Description | | 4.3 liter (262 cid) |
|---|---|---|
| Valve Stem Oil Seal | Installed Height [1] | 1 - 2 mm (0.0394 - 0.0787 in.) |

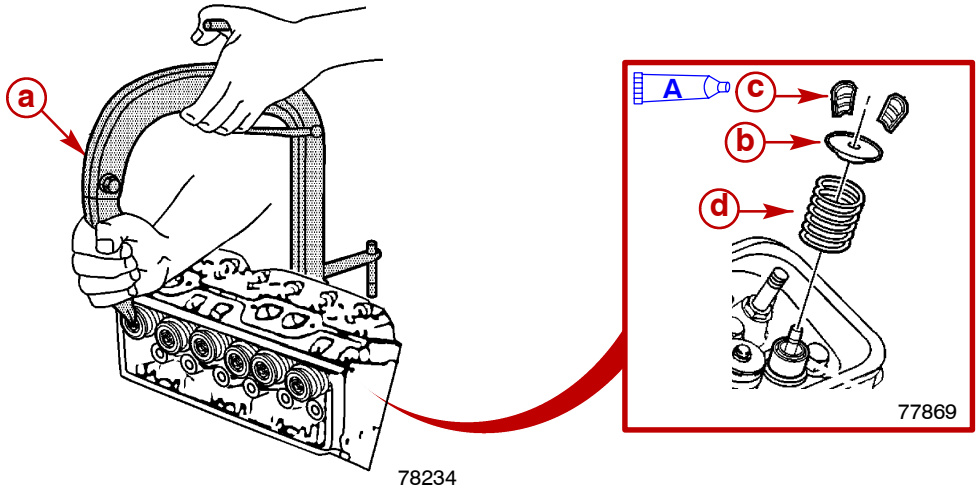
[1] Measured from top of valve guide bevel to bottom of oil stem seal.

8. Install valve spring.
9. Place valve spring cap on valve spring.

**⚠ CAUTION**

**Improperly compressed springs or improperly locked valve caps could allow the spring to be ejected with tremendous force, which could cause personal injury. Use care when compressing the valve springs or releasing the valve spring compressor tool.**

10. Compress the valve spring using valve spring compressor.
11. Coat the valve stem locks with lubricant to hold in place.
12. Install the valve stem locks.
13. Ensure valve stem locks are seated properly in the groove of the valve stem.

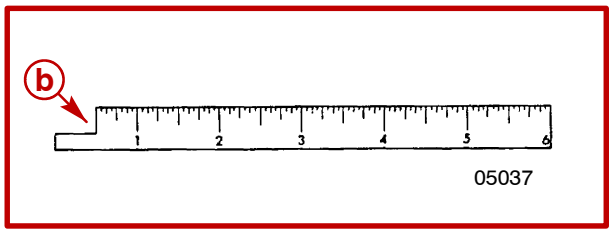


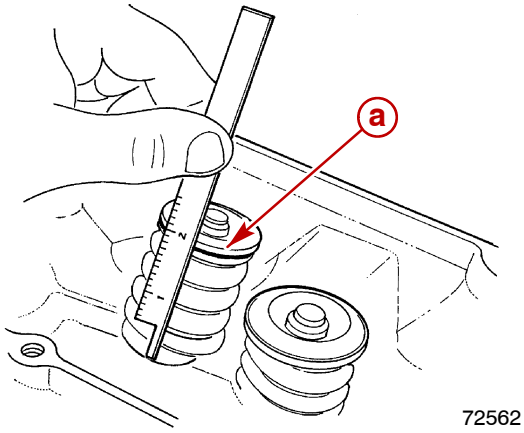

**a** - Valve Spring Compressor (J8062)
**b** - Cap
**c** - Valve Locks
**d** - Spring

| Description | | Where Used | Part Number |
|---|---|---|---|
| A | Needle Bearing Assembly Lubricant | Valve stem locks | 92-082868A1 |

14. Slowly release valve spring compressor.
15. Set assembly by tapping valve stem with a soft (plastic) hammer.
16. Check installed height of valve springs using a narrow, thin scale. Measure from spring seat to top of valve spring.

**IMPORTANT: If measurement exceeds specified height, install a valve spring shim and recheck. Do NOT shim valve springs to give an installed height less than the minimum specified.**



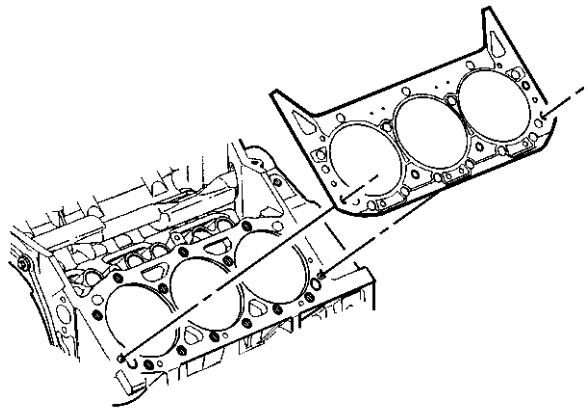

**Typical**

**a** - Valve Spring Installed Height
**b** - Cut Away Scale

| Description | | 4.3 liter (262 cid) |
|---|---|---|
| Installed Height | Intake | 42.92-43.43 mm (1.6898-1.7098 in.) |
| | Exhaust | |

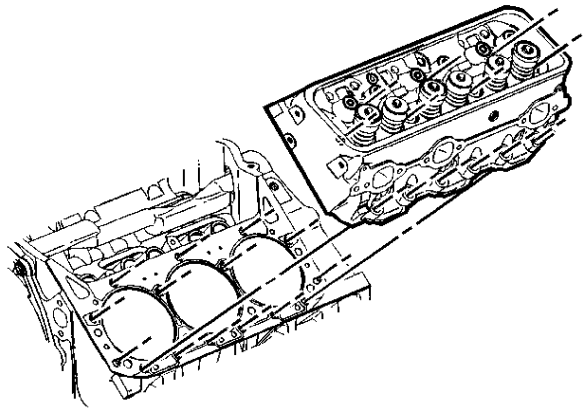
## Installation

1. Ensure the engine block and cylinder head sealing surfaces are clean.
2. Place a new head gasket in position over dowel pins.



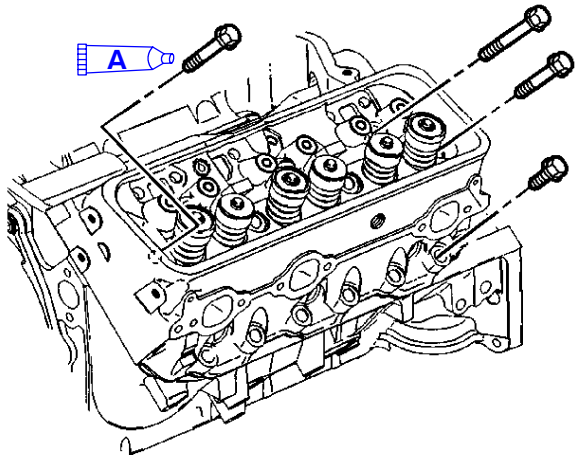
78208

3. Carefully set cylinder head in place over dowel pins.



78226

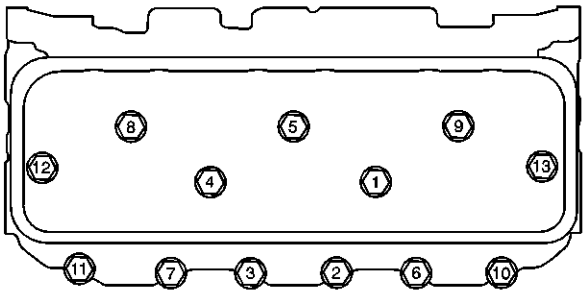
4. Coat threads of cylinder head bolts with sealant and install bolts finger-tight.




78225

| Description | | Where Used | Part Number |
|---|---|---|---|
| A | Loctite 565 PST | Cylinder head bolts | Obtain Locally |

5. Torque cylinder head bolts in passes using numbered sequence shown.




78243

**Cylinder Head Torque Sequence**

**a** - Long Bolts (Sequence Numbers - 5, 8, 9, 12 and 13)
**b** - Medium Bolts (1 and 4)
**c** - Short Bolts (2, 3, 6, 7, 10, and 11)

| Description | | | Nm | lb-in. | lb-ft |
|---|---|---|---|---|---|
| Cylinder Head Bolt - Preferred Method | | | | | |
| All Bolts In Sequence | First Pass | | 30 | | 22 |
| In Sequence Angle Torque | Final Pass | Long Bolts | + 75 degrees | | |
| | | Medium Bolts | + 65 degrees | | |
| | | Short Bolts | + 55 degrees | | |
| Cylinder Head Bolt - Optional Method | | | | | |
| All Bolts In Sequence | First Pass | | 35 | | 26 |
| | Second Pass | | 60 | | 44 |
| | Final Pass | | 90 | | 66 |

**IMPORTANT: Keep pushrods and rocker arm assemblies together as a matched set. Install parts in the same location.**

6. Install pushrods and rocker arm assemblies in their original positions.
7. Install intake manifold assembly.
8. Install valve covers.
9. Install any components removed such as the ECM, belt, pulleys, water circulating pump, throttle cable and other components.
10. Install exhaust manifolds and elbows.
11. Refill closed cooling system.

**⚠ CAUTION**

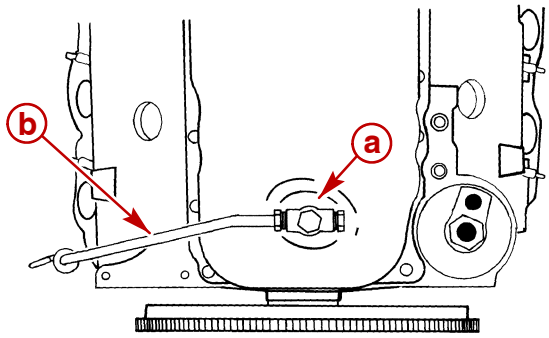
**Overheating from insufficient cooling water will cause engine and drive system damage. Ensure that there is sufficient water always available at water inlet holes during operation.**

12. Provide sufficient water supply to water inlet holes.
13. Start engine.
14. Check for leaks.

# Oil Pan

## Removal

1. Drain engine oil from oil pan.
2. Disconnect the oil drain fitting and hose.




71859

**Typical**

**a** - Oil Pan Fitting
**b** - Dipstick Tube

3. Remove oil pan.
4. Remove and discard the oil pan gasket.

## Cleaning

1. Put on safety glasses.
2. Clean sealing surfaces of engine block and oil pan.
3. Clean oil pan in cleaning solvent.
4. Dry parts with compressed air.

## Inspection

1. Inspect oil pan for cracks, holes, warped sealing surfaces or other damage.
2. Replace oil pan if necessary.

## Installation

**IMPORTANT: The adhesive sets up in about 15 minutes. Complete the assembly while adhesive is still wet.**

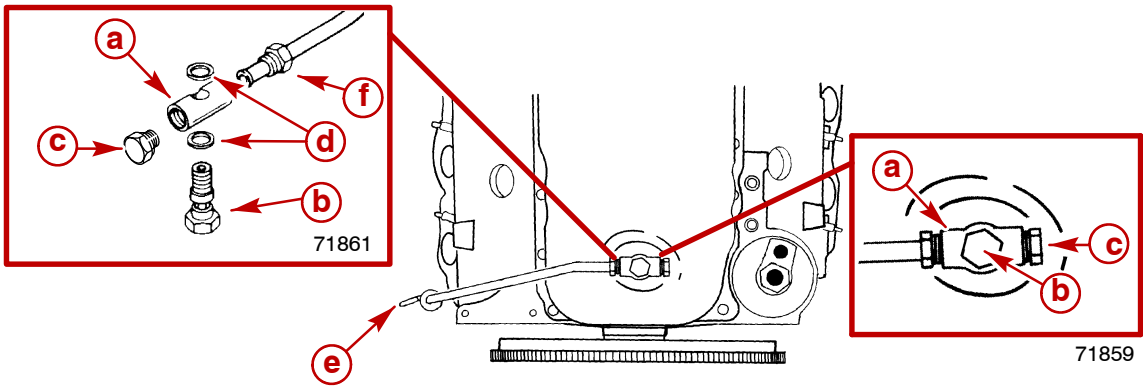
1. Apply a 5 mm (13/64 in.) wide and 25 mm (1 in.) long bead of adhesive to both the right and left side joints of rear seal retainer and joints of front cover.

**IMPORTANT: Always install a new oil pan gasket.**

2. Install a new oil pan gasket.
3. Install oil pan.
4. Ensure that the oil pan gasket is pressed into the grooves of the engine front cover and crankshaft rear oil seal housing.
5. Starting from the center and working outward in each direction, torque oil pan stud nuts and oil pan bolt or stud.

| Description | Nm | lb-in. | lb-ft |
|---|---|---|---|
| Oil Pan Stud Nut | 25 | | 18 |
| Oil Pan Bolt or Nut | 12 | 106 | |

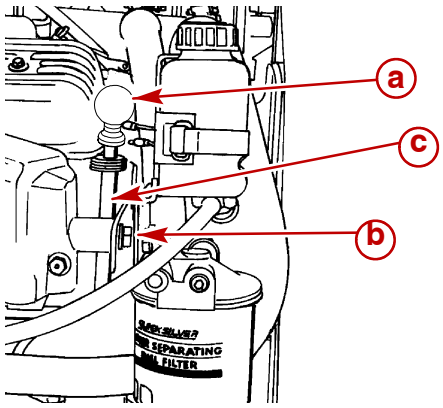
6. Install oil drain fitting and hose.
   a. Install the plug in the oil pan fitting.
   b. Securely tighten plug at fitting.
   c. Torque oil pan fitting hollow bolt.




**a** - Oil Pan Fitting
**b** - Hollow Bolt
**c** - Plug
**d** - Gaskets
**e** - Dipstick Tube
**f** - Sleeve Nut

| Description | Nm | lb-in. | lb-ft |
|---|---|---|---|
| Oil Pan Fitting Hollow Bolt | 20 | 180 | |

d. Install appropriate engine oil dipstick.

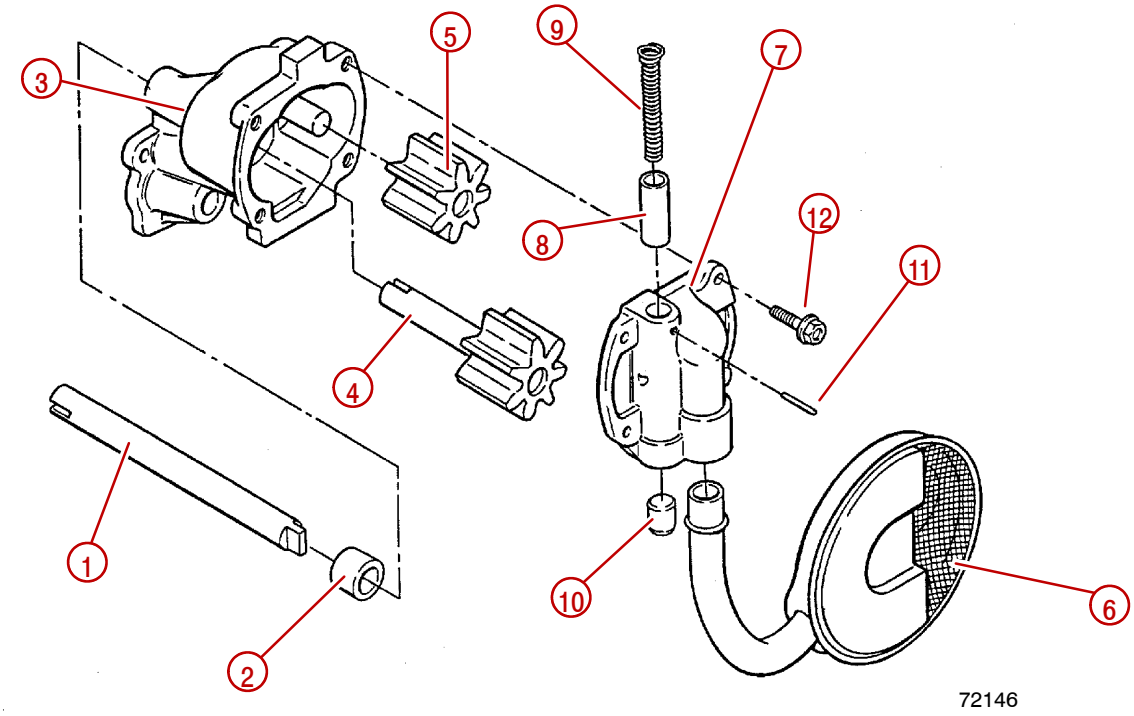



**a** - Dipstick
**b** - Clamp
**c** - Dipstick Tube

7. Fill crankcase with specified engine oil. Refer to SECTION 1B.

# Oil Pump

## Exploded View

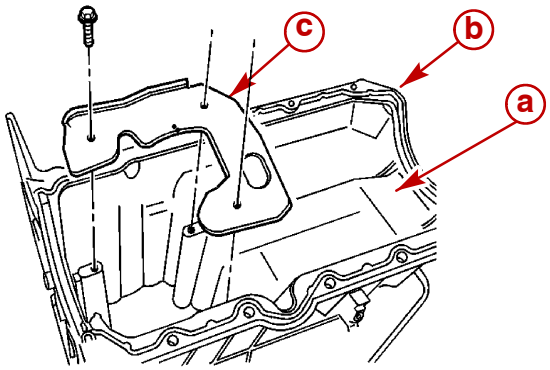



**Oil Pump Assembly**

1 - Driveshaft
2 - Driveshaft Retainer
3 - Pump Body
4 - Drive Gear And Shaft
5 - Idler Gear
6 - Pick Up Screen And Suction Pipe
7 - Pump Cover
8 - Pressure Regulator Valve
9 - Pressure Regulator Spring
10 - Plug
11 - Retaining Pin
12 - Screw (4)

## Removal

1. Remove oil pan.
2. Remove and discard the oil pan gasket.
3. Remove oil pan baffle.



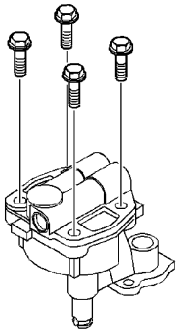

78220

**a** - Oil Pan
**b** - Oil Pan Gasket
**c** - Oil Pan Baffle

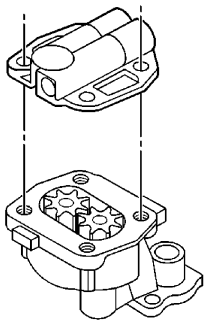
4. Remove oil pump, driveshaft retainer and driveshaft.

## Disassembly

1. Remove pump cover.



78249

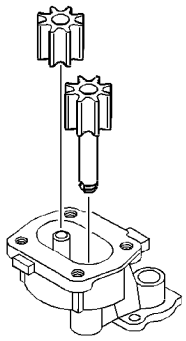


78250

**IMPORTANT: Gear teeth must be marked for exact repositioning when reassembled.**

2. Make alignment marks on the idler gear and drive gear teeth.

3. Remove idler gear and drive gear from pump body.



78251

**⚠ CAUTION**

**Pressure regulator valve spring is compressed. Use care when removing or installing retaining pin to prevent personal injury.**

4. Put on safety glasses.
5. Remove retaining pin, spring and pressure regulator valve from pump cover.

**⚠ CAUTION**

**Do not remove suction pipe and pickup screen assembly unless replacement is necessary. Loss of press fit condition could result in an air leak and loss of oil pressure causing engine damage. The pipe and screen are serviced as an assembly.**

6. If pickup screen and suction pipe assembly require replacement, mount pump in a soft-jawed vise and extract the suction pipe from the pump.

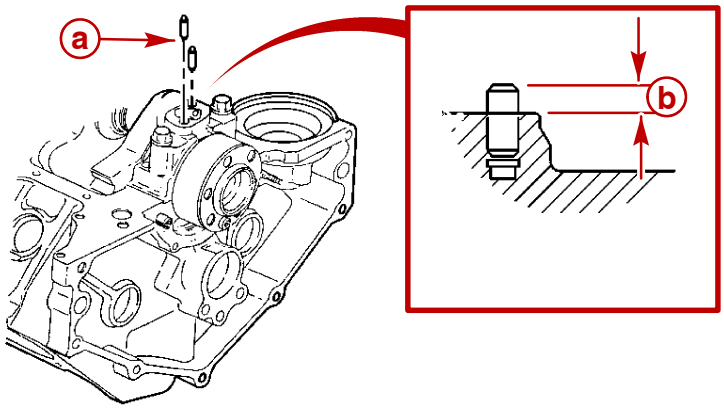
## Cleaning

1. Put on safety glasses.
2. Clean all parts in cleaning solvent.
3. Dry parts with compressed air.

## Inspection

**IMPORTANT: Pump gears and body are not serviced separately. If pump gears or body are damaged or worn, replacement of entire oil pump assembly is necessary.**

1. Inspect pump body and cover for cracks or excessive wear.
2. Inspect pump gears for damage and excessive wear, such as chipped teeth and galling.
3. Check gear shafts in pump body for galling, scoring or excessive shaft-to-bore clearance.
4. Inspect inside of pump cover for wear that would permit oil to leak past ends of gears.
5. Inspect pickup screen and suction pipe assembly for damage.
6. Check pressure regulator valve for smooth, non-binding fit in bore of oil pump cover.
7. Inspect the oil pump locator dowel pins for damage and proper height.




77874

**a** - Dowel Pins
**b** - Measurement

| Description | Height |
|---|---|
| Oil Pump Dowel Pin | 6.4 mm (0.2520 in.) |

## Reassembly

**IMPORTANT: Liberally coat oil pump internal parts before installation.**

1. Liberally coat surfaces of pressure regulator valve, pressure relief spring and pressure regulator bore in oil pump with lubricant.

| Description | Where Used | Part Number |
|---|---|---|
| Engine Oil | Pressure regulator valve, pressure relief spring and pressure regulator bore | Obtain Locally |

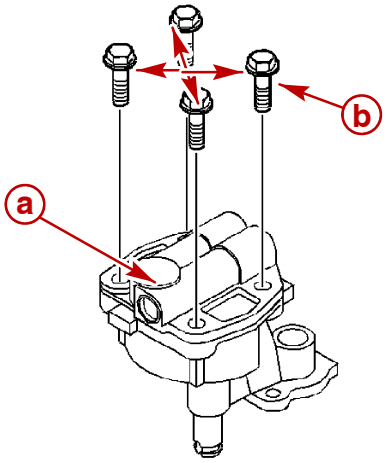
**⚠ CAUTION**

**Pressure regulator valve spring is compressed. Use care when removing or installing retaining pin to avoid personal injury.**

2. Put on safety glasses.
3. Install pressure regulator valve, a new pressure relief spring if reusing existing pump and retaining pin.
4. Liberally coat surfaces of oil pump gears and shafts with lubricant.

| Description | Where Used | Part Number |
|---|---|---|
| Engine Oil | Oil pump gears | Obtain Locally |

5. Install drive gear in pump body.
6. Install idler gear in pump body with smooth side of gear toward pump cover.
7. Align gear teeth marks made in disassembly.
8. Fill gear cavity with engine oil.
9. Install oil pump cover and cover bolts. Torque bolts in a diagonal pattern.




77862

**a** - Cover
**b** - Bolts

| Description | Nm | lb-in. | lb-ft |
|---|---|---|---|
| Oil Pump Cover Bolt | 12 | 106 | |

10. Turn oil pump driveshaft by hand to ensure smooth pump operation.

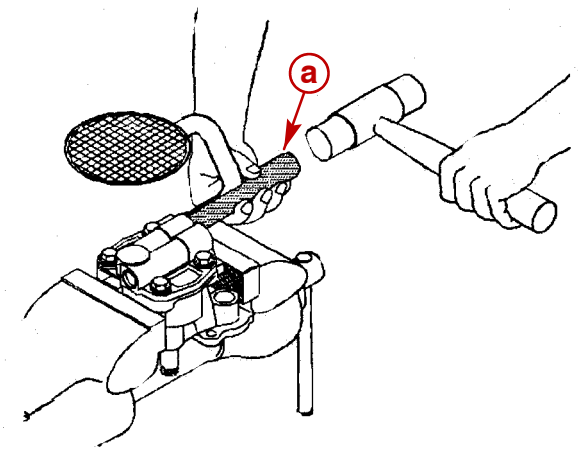
**⚠ CAUTION**

**Be careful of twisting, shearing or collapsing the suction pipe while installing in pump. Pickup screen must be parallel to oil pan bottom when oil pump is installed.**

11. If pickup screen and pipe assembly was removed:
    a. Mount pump in a soft-jawed vise.
    b. Apply sealant to end of new pipe.

| Description | | Where Used | Part Number |
|---|---|---|---|
| A | Loctite 565 PST | Oil pickup screen pipe to oil pump body | Obtain Locally |

    c. Using the suction pipe installer tool, tap the suction pipe in place with a hammer.




78149

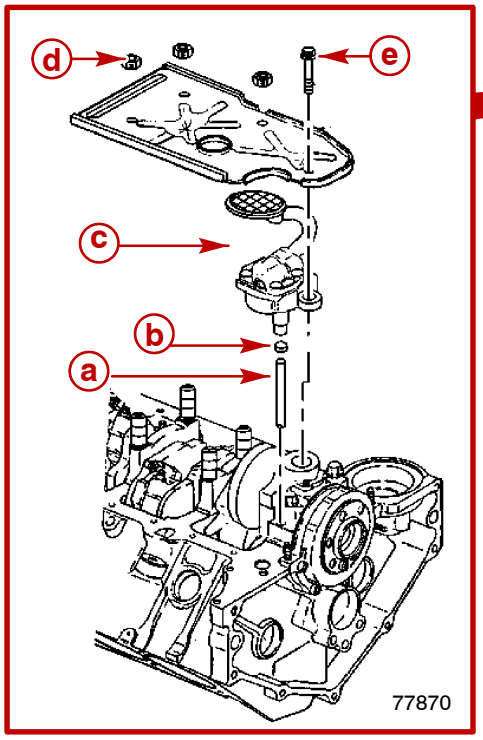
**a** - Suction Pipe Installer Tool (J-21882)

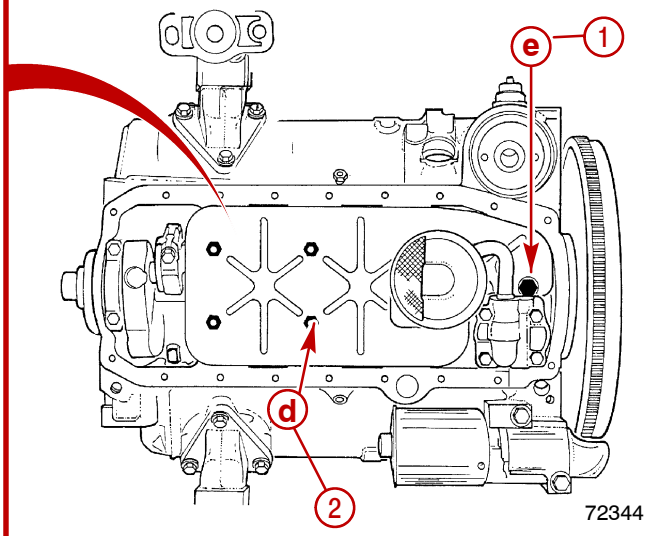
    d. Ensure that the pickup screen is parallel to the oil pan bottom when installed.

# Installation

**IMPORTANT: Do NOT reuse the oil pump driveshaft retainer. Oil pump driveshaft retainer must be replaced.**

1. Align oil pump driveshaft with distributor driveshaft.
2. Instal oil pump driveshaft, a new driveshaft retainer and oil pump to rear main bearing cap.
3. Install crankshaft oil deflector, nuts and oil pump bolt.
4. Torque oil pump bolt and oil deflector nuts.




**a** - Driveshaft
**b** - Driveshaft Retainer
**c** - Oil Pump Assembly
**d** - Oil Deflector Nut
**e** - Oil Pump Bolt

| Description | | | Nm | lb-in. | lb-ft |
|---|---|---|---|---|---|
| 1 | Oil Pump Bolt (To Rear Crankshaft Bearing Cap) | | | | |
| | | First Pass | 20 | | 15 |
| | | Final Pass | + 65 degrees | | |
| 2 | Oil Deflector Nut | | 40 | | 30 |

**IMPORTANT: Always install a new oil pan gasket.**

5. Install a new oil pan gasket.
6. Install oil pan.

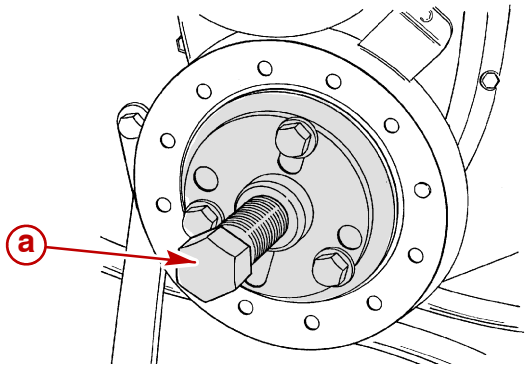
# Crankshaft Balancer

## Removal

1. Remove drive belt.
2. Remove crankshaft drive pulley.
3. Remove crankshaft balancer retaining bolt.

**IMPORTANT: Do not use a universal claw type puller to remove crankshaft balancer as outside ring of balancer is bonded in rubber to the hub. Use of claw type puller may break the bond.**

4. Remove crankshaft balancer with remover and installer tool.




72345

**a** - Crankshaft Balancer Remover And Installer Tool (J23523 F).

## Cleaning

1. Put on safety glasses.
2. Clean the crankshaft balancer in cleaning solvent.
3. Dry the parts with compressed air.

## Inspection

1. Inspect crankshaft balancer for worn or damaged bolt hole threads.
2. Inspect crankshaft balancer for damaged or deteriorated rubber between inner and outer pieces.
3. Inspect crankshaft balancer for improperly installed or loose balance weights.
4. Inspect crankshaft balancer keyway for damage.

## Installation

**IMPORTANT: The inertia weight section of the crankshaft balancer is bonded to the hub with a rubber type material. The installation procedure (with proper tool) must be followed or movement of the inertia weight on the hub will destroy the tuning of the crankshaft balancer.**

1. Coat seal surface of crankshaft balancer with engine oil.

| Description | Where Used | Part Number |
|---|---|---|
| Engine Oil | Crankshaft Balancer Seal Surface | Obtain Locally |

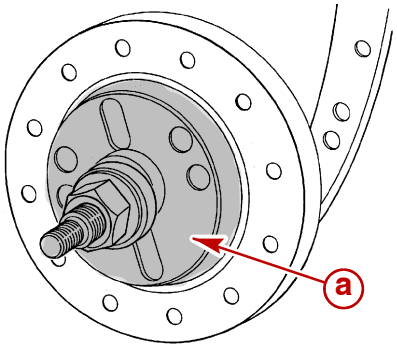
2. Replace crankshaft key if it is damaged.
3. To prevent oil leaks, apply sealant to crankshaft balancer keyway.

| Description | Where Used | Part Number |
|---|---|---|
| Ultra-Black Loctite 5900 | Crankshaft Balancer Keyway | 92-809826 |

4. Align the keyway of the crankshaft balancer with the crankshaft balancer woodruff key.
5. Use the Balancer Remover and Installer Tool J23523-F to press the crankshaft balancer onto the crankshaft.
   a. Install the plate and bolts onto the front of the crankshaft balancer and torque the bolts.

| Description | Nm | lb-in. | lb-ft |
|---|---|---|---|
| J23523-F Plate Bolts | 25 | | 18 |

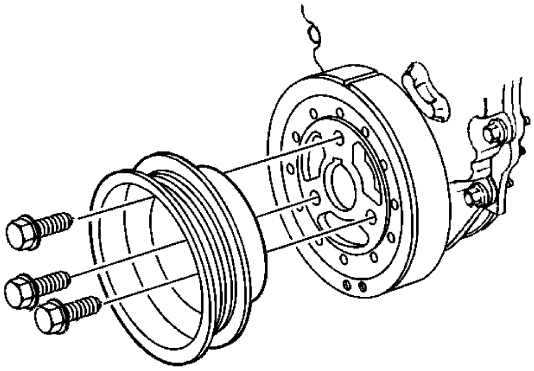
   b. Install the screw into the end of the crankshaft.
   c. Install the bearing, the washer and the nut onto the screw.
   d. Rotate the nut clockwise until the crankshaft balancer hub is completely seated against the crankshaft position sensor reluctor ring.
6. Remove the Balancer Remover and Installer Tool.




72346

**a** - Crankshaft Balancer Remover And Installer Tool (J23523-F)

7. Install crankshaft pulley. Torque bolts.



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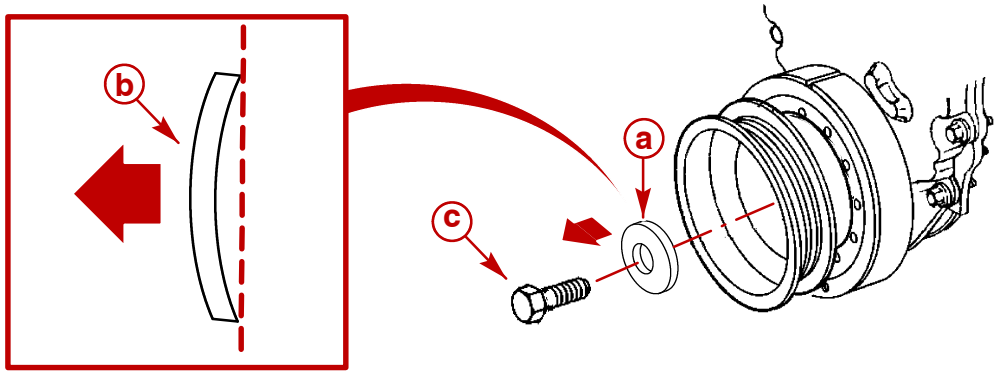
| Description | Nm | lb-in. | lb-ft |
|---|---|---|---|
| Crankshaft Pulley Bolt | 58 | | 43 |

a. Install crankshaft balancer washer with washer crown facing front of engine.

b. Install crankshaft balancer bolt. Torque bolt.




77887

**a** - Washer
**b** - Washer Crown
**c** - Bolt

| Description | Nm | lb-in. | lb-ft |
|---|---|---|---|
| Crankshaft Balancer (Torsional Damper) Bolt | 95 | | 70 |

8. Install and adjust drive belts.

# Front Cover Oil Seal

## Oil Seal Replacement Without Removing Front Cover

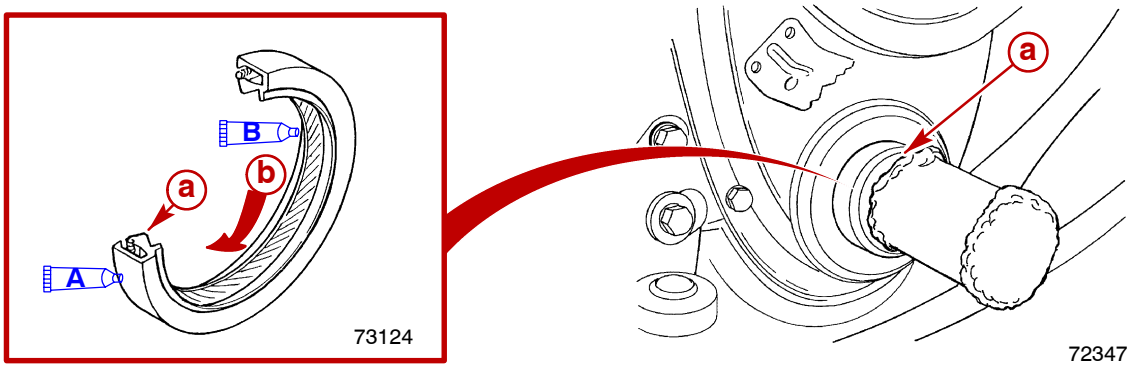
### REMOVAL

1. Remove belts and pulleys.
2. Remove crankshaft balancer.
3. Pry seal out of cover from the front with a large screwdriver. Be careful not to distort front cover or damage crankshaft.

### INSTALLATION

1. Apply sealant to the seal mating surface and lubricate seal edge.
2. Install new seal with open end of seal inward, using crankcase front cover seal installer. Drive seal in until it just contacts.

**IMPORTANT:** Do not use excessive force installing seal.




**a** - Seal Edge
**b** - Rotation Of Crankshaft As Viewed From Front End Looking Toward Flywheel End
**c** - Crankcase Front Cover Seal Installer (J35468)

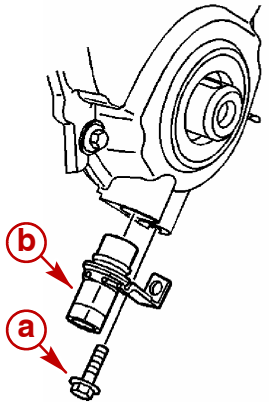
| Description | | Where Used | Part Number |
|---|---|---|---|
| A | Ultra-Black Loctite 5900 | Front cover seal retainer-to-seal mating surface | 92-809826 |
| B | Engine Oil | Front seal lips | Obtain Locally |

3. Reinstall crankshaft balancer.

# Front Cover

## Removal

1. Drain engine seawater and closed cooling systems.
2. Remove the serpentine belt.
3. Remove the crankshaft pulley.
4. Remove the hoses from the water circulating pump.
5. Remove crankshaft balancer.
6. Remove water circulating pump.
7. Remove oil pan.
8. Remove the crankshaft position sensor.




77871

**a** - Sensor Bolt
**b** - Sensor

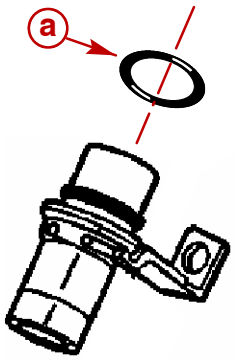
**IMPORTANT: Crankcase front cover is not reusable per manufacturer's specification. It must be replaced if removed.**

9. Remove and discard crankcase front cover.

## Cleaning and Inspection

**IMPORTANT: Surfaces must be clean or oil may leak.**

1. Clean old gasket material and sealer from sealing surfaces on engine block.
2. Remove and discard the crankshaft position sensor O-ring seal.




78151

**a** - Sensor O-ring

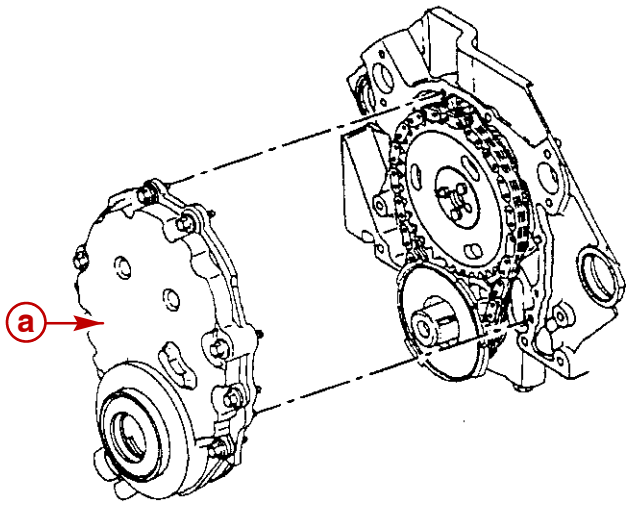
## Installation

***NOTE:*** *New front covers are complete with gasket material and a seal.*

1. Lubricate seal edge.

| Description | Where Used | Part Number |
|---|---|---|
| Engine Oil | Front seal lips | Obtain Locally |

2. Install new front cover, ensuring holes in cover align with dowel pins in block. Torque front cover bolts.




77865

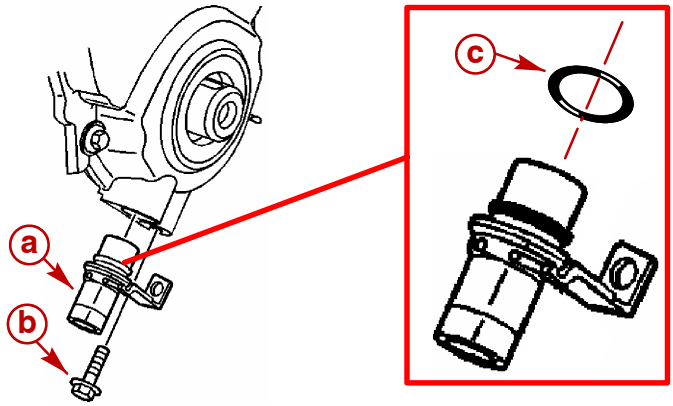
**a** - Front Cover

| Description | Nm | lb-in. | lb-ft |
|---|---|---|---|
| Front Cover Bolt | 12 | 106 | |

3. Install a new crankshaft position sensor O-ring seal.

**IMPORTANT: Ensure that the crankshaft position sensor is fully seated in the front cover. Erratic engine operation can occur if sensor is not completely and properly mounted.**

4. Install crankshaft position sensor. Ensure that the sensor is fully seated in cover.
5. Install crankshaft position sensor bolt. Torque bolt.




77871

**a** - Sensor
**b** - Sensor Bolt
**c** - O-ring

| Description | Nm | lb-in. | lb-ft |
|---|---|---|---|
| Crankshaft Position Sensor Bolt | 9 | 80 | |

6. Install the oil pan.
7. Install the crankshaft balancer.
8. Install the water circulating pump.
9. Install the hoses to the water circulating pump.
10. Fill the crankcase with engine oil. Refer to SECTION 1B.
11. Refill the closed cooling system.
12. Install the crankshaft pulley.
13. Install the serpentine belt.

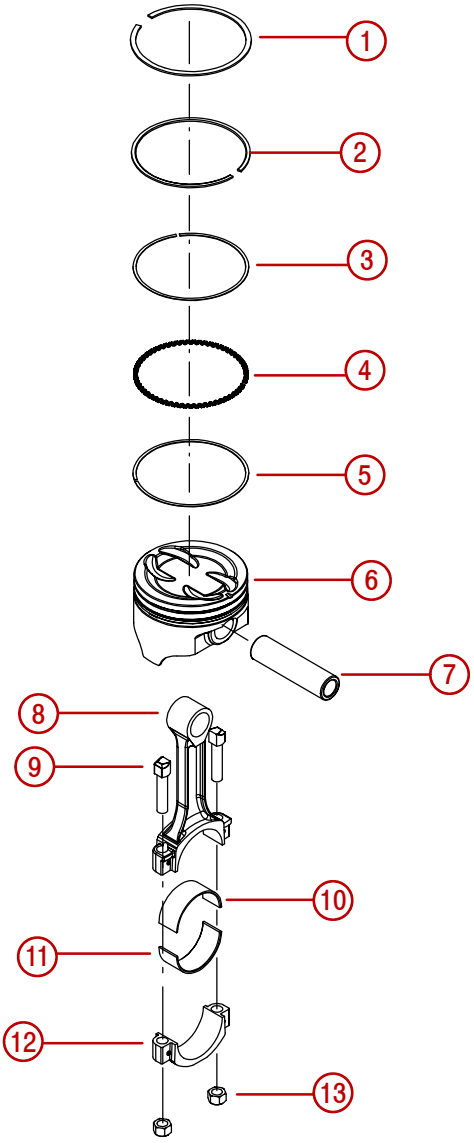
**⚠ CAUTION**

**Overheating from insufficient cooling water will cause engine and drive system damage. Ensure that there is sufficient water always available at water inlet holes during operation.**

14. Provide sufficient water supply to water inlet holes.
15. Start engine and check for water and oil leaks.

# Connecting Rod, Bearings and Piston Assembly

## Exploded View

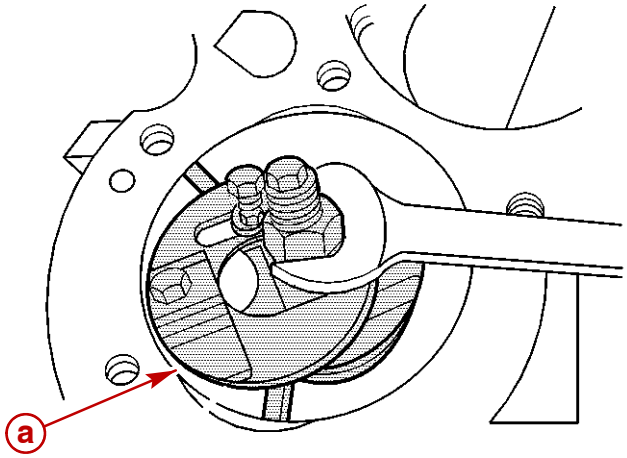



77888

**1** - Upper Compression Ring
**2** - Lower Compression Ring
**3** - Upper Oil Control Ring
**4** - Oil Control Ring Spacer
**5** - Lower Oil Control Ring
**6** - Piston
**7** - Piston Pin
**8** - Connecting Rod
**9** - Bolt
**10** - Upper Bearing Half
**11** - Lower Bearing Half
**12** - Bearing Cap
**13** - Nut

## Removal

1. Remove the engine cover.
2. Remove all components on the front of the engine.
3. Remove exhaust elbow and manifold assemblies.
4. Remove the valve covers.
5. Remove distributor and intake manifold assembly.
6. Remove cylinder heads.
7. Remove dipstick tube and oil pan.
8. Remove crankshaft oil deflector and oil pump.
9. Using a ridge reamer (J24270), remove any ridge or combustion deposits from top of cylinder bore.
   a. Turn crankshaft until piston is at bottom of stroke.
   b. Place a cloth on top of piston to collect cuttings.
   c. Use the cylinder bore ridge reamer (J24270) to remove ridge or deposits.
   d. Turn crankshaft until piston is at top of stroke.
   e. Remove cloth and cuttings.




78199

**a** - Cylinder Bore Ridge Reamer (J24270)

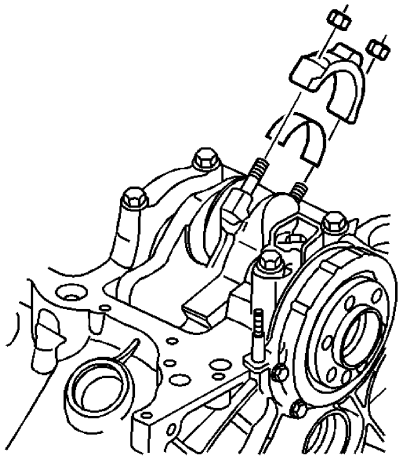
10. Turn crankshaft to gain access to connecting rods and bolts.

**IMPORTANT: Mark the location of each connecting rod assembly so that they can be reassembled in the same location later.**

11. Mark connecting rods and bearing caps to corresponding cylinder number (port bank 1, 3 and 5; starboard bank 2, 4 and 6 from front to rear on same side as piston thrust).

**IMPORTANT: Before removing the connecting rod cap, mark and organize the connecting rods and caps so that they can be installed in the same location later.**

12. Remove connecting rod bearing cap.



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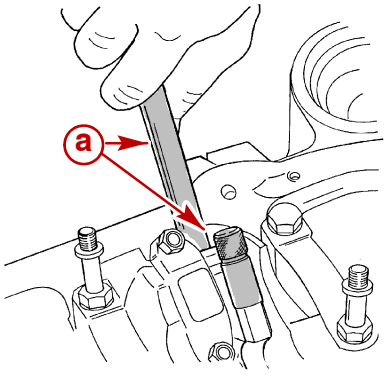
**IMPORTANT: Connecting rod bolt threads can damage crankshaft journal and cylinder bore.**

13. Cover connecting rod bolt threads with bolt guides. It is acceptable to use clean rubber tubing for the connecting rod bolt guides.




72364

**a** - Connecting Rod Bolt Guides (J5239)

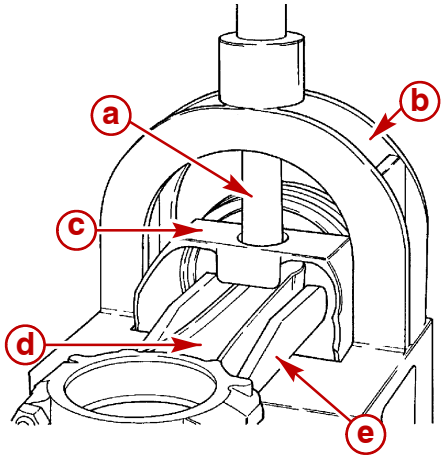
14. Push piston and connecting rod out of cylinder.

**IMPORTANT: The mating surfaces of the connecting rods and the connecting rod bearing caps form an individual fit and as a result must not be interchanged or damaged under any circumstances. To avoid damage, do not lay connecting rods or connecting rod bearing caps on their mating surfaces.**

15. Remove the connecting rod bearings. Keep the bearings with the original connecting rod and connecting rod cap together as a matched set.

## Disassembly

1. Remove the piston rings from the pistons.
2. Press piston pin from connecting rod using a piston pin remover. Follow tool manufacturer's instructions.




72365

**a** - Piston Pin Remover (J24086-C)
**b** - Arched Base
**c** - Piston
**d** - Connecting Rod
**e** - Rod Support

3. Mark, separate and organize parts so that they can be reinstalled in the same location.

## Cleaning

### CONNECTING RODS

1. Put on safety glasses.
2. Clean connecting rods in cleaning solvent.
3. Dry parts with compressed air.

### CONNECTING ROD BEARINGS

1. Put on safety glasses.
2. Clean connecting rod bearings in cleaning solvent.
3. Wipe bearings clean with a soft cloth. Do NOT scratch the bearing contact surfaces.
4. Dry parts with compressed air.

### PISTONS

**IMPORTANT: Do not wire brush any part of a piston.**

1. Put on safety glasses.
2. Clean pistons in cleaning solvent.
3. Clean varnish from piston skirts and pins with a suitable cleaning solvent.
4. Clean piston ring grooves.
5. Clean piston oil lubrication holes and slots.
6. Dry parts with compressed air.

### PISTON PIN

1. Put on safety glasses.
2. Clean parts in cleaning solvent and dry with compressed air.
3. Dry parts with compressed air.

## Inspection

**IMPORTANT: Measurements should be taken when components are at room temperature.**

### CONNECTING ROD

1. Check for twisted and bent connecting rods.
2. Inspect for nicks and cracks.
3. Inspect for damage to the bearing cap and bolt threads.

### CONNECTING ROD BEARINGS

***NOTE:*** *Refer to Crankshaft, Main Bearings and Engine Block - Main Bearings, for examples of bearing failures similar to the following.*

1. Inspect the connecting rod bearings for craters, pockets or flattened sections.
2. Inspect the connecting rod bearings for excessive scoring, discoloration or damage.
3. Inspect the connecting rod bearings for dirt or debris imbedded in the bearing material.
4. Replace damaged or faulty bearings.

## CONNECTING ROD BEARING CLEARANCE - MICROMETER METHOD

Connecting rod bearings are of the precision insert type and do not use shims for adjustment. If clearances are found to be excessive, a new bearing will be required. Service bearings are available in standard size and .001 in. and .002 in. undersize for use with new and used standard size crankshafts. They are also available in .010 in. and .020 in. undersize for use with reconditioned crankshafts.

When removing a connecting rod cap, you may find a .010 in. undersize bearing. These are used in manufacturing for selective fitting.

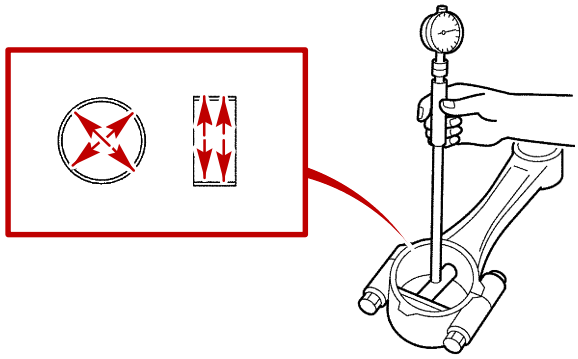
The micrometer method is the preferred method of determining connecting rod bearing clearance.

1. Wipe both upper and lower connecting rod bearings clean.
2. Install the upper and lower connecting rod bearings.
3. Install the bearing cap. Bearing cap MUST be torqued to specification in order to ensure proper reading.
4. In a two pass sequence, torque nuts.

| Description | | Nm | lb-in. | lb-ft |
|---|---|---|---|---|
| Connecting Rod Nut | | | | |
| | First Pass | 27 | | 20 |
| | Final Pass (Angle Torque) | + 70 degrees | | |

5. Use an inside dial indicator to measure the connecting rod bearing inside diameter, out of round and taper. Measure in several places approximately 90 degrees apart and average the measurements.

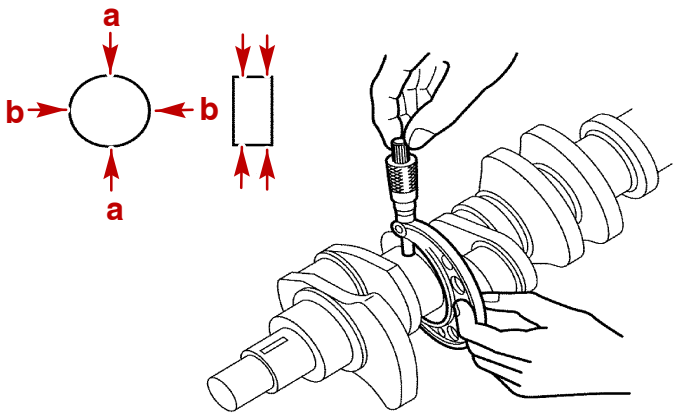
**IMPORTANT: Do not measure diameter close to split line for rod and bearings.** Bearings are eccentric and false readings could occur.



77217

**Measuring Connecting Rod Bearing Inside Diameter**

6. Record the measurements.
7. Wipe crankshaft connecting rod journal clean of oil.
8. Using a micrometer measure crankshaft connecting rod journal diameters at points "**a**" and "**b**" on one side of journal then repeat measurements on opposite side of journal.

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**Connecting Rod Journal Measurement - Typical Crankshaft Shown**

| **Description** | | **4.3 liter (262 cid)** |
|---|---|---|
| Diameter | | 57.116-57.148 mm (2.2487-2.2497 in.) |
| Taper | Production | 0.00508 mm (0.0003 in.) |
| | Service | 0.025 mm (0.0010 in.) |
| Out of Round | Production | 0.007 mm (0.0003 in.) |
| | Service | 0.025 mm (0.0010 in.) |

9. If journal diameters are not within specifications, replace or recondition the crankshaft.

**⚠ CAUTION**

**Avoid bearing failure. If a bearing is being fitted to an out-of-round journal, be sure to fit bearing to the maximum diameter of the journal. If the bearing is fitted to the minimum diameter and the journal is out of round 0.0254 mm (0.001 in.), interference between the bearing and journal will result in rapid bearing failure.**

10. If journal diameters are within specifications, determine bearing clearance by subtracting the crankshaft connecting rod journal outer diameter from the inner diameter of the bearing.

| Description | | 4.3 liter (262 cid) |
|---|---|---|
| Clearance | Production | 0.038-0.078 mm (0.0015-0.0031 in.) |
| | Service Limit | 0.025-0.063 mm (0.0010-0.0025 in.) |

11. If the clearance exceeds specifications, select a new, correct size bearing and determine the clearance.

## CONNECTING ROD BEARING CLEARANCE - PLASTIC GAUGE METHOD

The plastic gauge method is an optional method of determining connecting rod bearing clearance. The preferred method use a micrometer.

1. Wipe both upper and lower bearings and crankshaft connecting rod journal clean of oil.
2. Install the bearings in the connecting rod and cap.

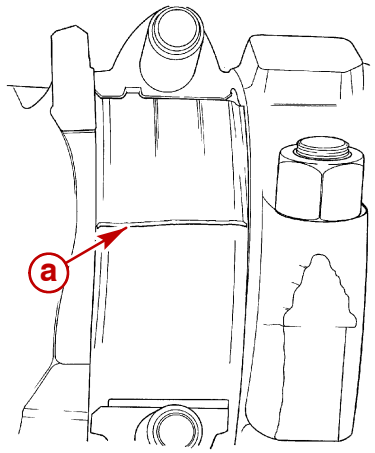
**⚠ CAUTION**

**Avoid possible engine bearing failure. The connecting rod and upper bearing must be seated against the connecting rod journal before installing the lower bearing and rod cap. Unreliable measurement may result if the journal and upper bearing are not fully seated.**

3. Rotate the crankshaft or move the connecting rod until the upper bearing is fully seated against the connecting rod journal being measured.

**IMPORTANT: Position the gauging plastic on the crankshaft journal in an area that will be the middle of the bearing shell.**

4. Place a piece of gauging plastic parallel to the crankshaft on the middle of the open crankshaft connecting rod journal surface as shown.




72361

**a** - Gauging Plastic

5. Install the bearing cap.

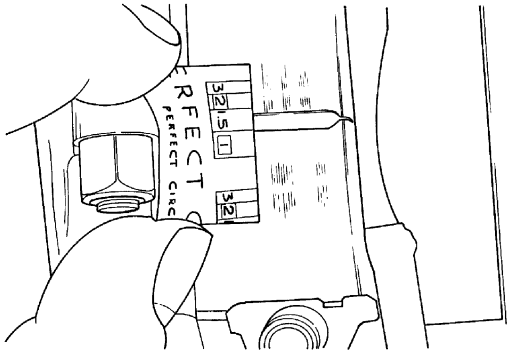
**IMPORTANT: Bearing cap MUST be torqued as specified to ensure proper measurement. Variations in torque affect the compression of the plastic gauge.**

6. In a two pass sequence, torque nuts.

| Description | | Nm | lb-in. | lb-ft |
|---|---|---|---|---|
| Connecting Rod Nut - 4.3 liter (262 cid) | | | | |
| | First Pass | 27 | | 20 |
| | Final Pass (Angle Torque) | + 70 degrees | | |

**IMPORTANT: Do not rotate the crankshaft while the gauging plastic is between the bearing and journal.**

7. Without rotating crankshaft, remove the bearing cap and use the scale on the gauging plastic envelope to measure the gauging plastic width at the widest point.




72362

**Measuring Connecting Rod Bearing Clearance**

| Description | | 4.3 liter (262 cid ) |
|---|---|---|
| Clearance | Production | 0.038-0.078 mm (0.0015-0.0031 in.) |
| | Service Limit | 0.025-0.063 mm (0.0010-0.0025 in.) |

8. If the clearance exceeds specifications, select a new, correct size bearing and remeasure the clearance. A standard and undersized connecting rod bearing combination may result in the proper clearance.

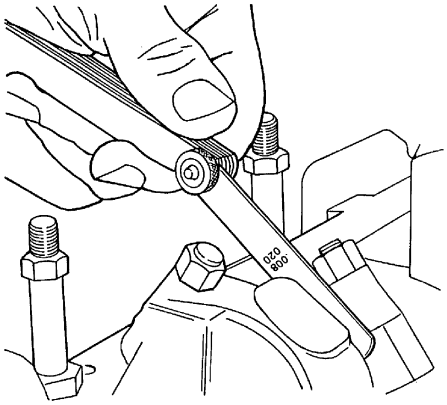
***NOTE:*** *If clearance cannot be brought to within specifications, the crankshaft connecting rod journal will have to be ground undersize. If the connecting rod journal is already at maximum undersize, replace crankshaft.*

9. Coat the selected bearing surface with oil.
10. Install the rod cap.
11. In a two pass sequence, torque nuts.

| Description | | Nm | lb-in. | lb-ft |
|---|---|---|---|---|
| Connecting Rod Nut - 4.3 liter (262 cid) | | | | |
| | First Pass | 27 | | 20 |
| | Final Pass (Angle Torque) | + 70 degrees | | |

## CONNECTING ROD SIDE CLEARANCE

1. When all connecting rod bearings have been installed, tap each rod lightly (parallel to the crankshaft) to ensure clearance.
2. Measure all connecting rod side clearances between connecting rod caps.




72363

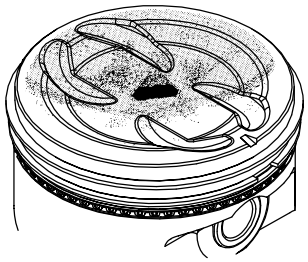
**Measuring Connecting Rod Side Clearance**

| Description | 4.3 liter (262 cid) |
|---|---|
| Rod Side Clearance | 0.15-0.44 mm (0.0059-0.017 in.) |

## PISTONS

***NOTE:*** *Cylinder bore and taper must be within specifications before pistons can be considered for re-use.*

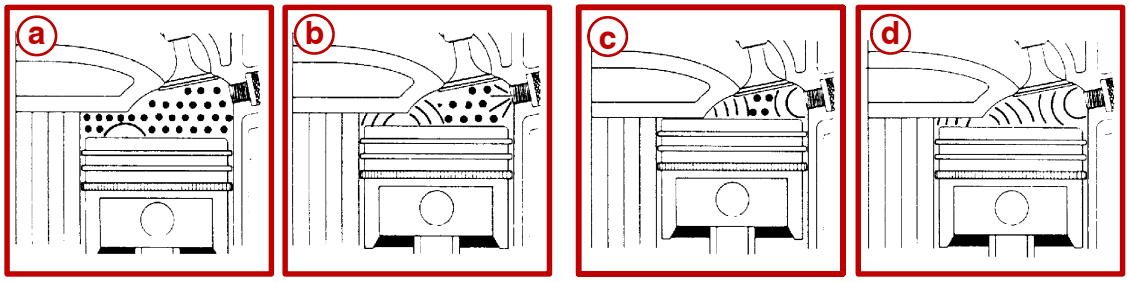
1. Replace pistons that are damaged or show signs of excessive wear.
2. Inspect the piston for damage caused by pre-ignition.



77889

**Pre-Ignition Damage**

Pre-ignition is abnormal fuel ignition caused by combustion chamber hot spots. Control of the start of ignition is lost, as combustion pressure rises too early, causing power loss and rough running. The upward motion on the piston is opposed by the pressure rise. This can result in extensive damage to the internal parts from the high increase in combustion chamber temperature.




72314

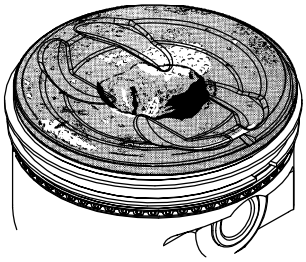
**a** - Ignited By Hot Deposits
**b** - Regular Ignition Spark
**c** - Ignites Remaining Fuel
**d** - Flame Fronts Collide

3. Inspect engine for causes of pre-ignition damage to pistons:
   a. Hot spots in the combustion chamber from glowing deposits (due to the use of improper oils and/or fuels).
   b. Overheated spark plug electrodes (improper heat range or defective plug).
   c. Any other foreign material in the combustion chamber, such as an overhanging piece of gasket, an improperly seated valve or any other inadequately cooled section of material that could serve as a source for pre-ignition problems.

***NOTE:*** *Engine failures that result from the foregoing conditions are beyond the control of Mercury MerCruiser. No warranty will apply to failures that occur under these conditions.*

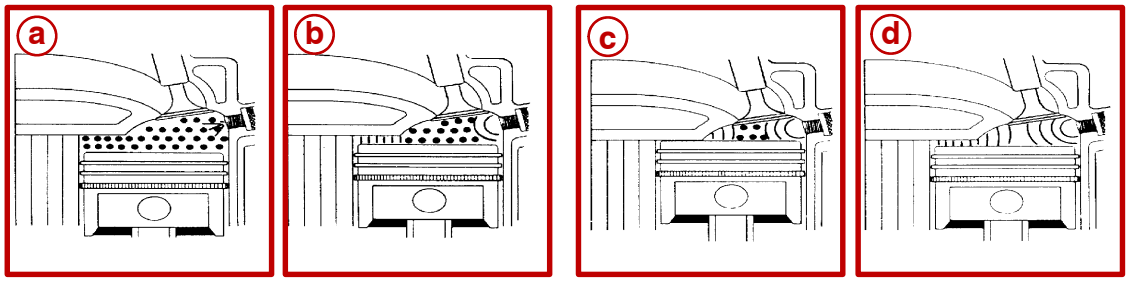
4. Inspect the piston for damage caused by detonation.

Detonation, commonly called fuel knock, spark knock or carbon knock, is abnormal combustion of the fuel causing the fuel to explode violently. The explosion causes overheating or damage to the spark plugs, pistons, valves and, in severe cases, results in pre-ignition.



77889

**Detonation Damage**




72315

**a** - Spark Occurs
**b** - Combustion Begins
**c** - Combustion Continues
**d** - Detonation Occurs

5. Inspect engine for causes of detonation damage to pistons:

**IMPORTANT: Use of improper fuels will cause engine damage and poor performance.**

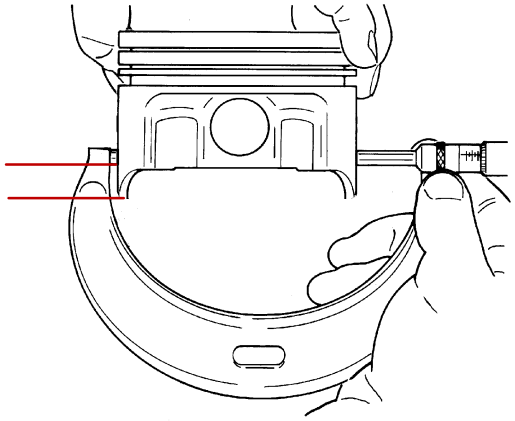
a. Use of low octane gasoline or neglecting engine maintenance.
b. Lean fuel mixture at or near full throttle (could be caused by leaking intake manifold).
c. Cross-firing spark plugs.
d. Excess accumulation of deposits on piston and/or combustion chamber that result in higher compression ratio.
e. Inadequate cooling of engine due to deterioration of cooling system.

***NOTE:*** *Engine failures that result from the foregoing conditions are beyond the control of Mercury MerCruiser. No warranty will apply to failures that occur under these conditions.*

6. Inspect piston for cracked ring lands, skirts and pin bosses, wavy or worn ring lands, scuffed or damaged skirts and eroded areas at top of piston.
7. Inspect ring grooves for nicks and burrs that might cause rings to bind.

8. Inspect piston wear by checking clearance as follows:

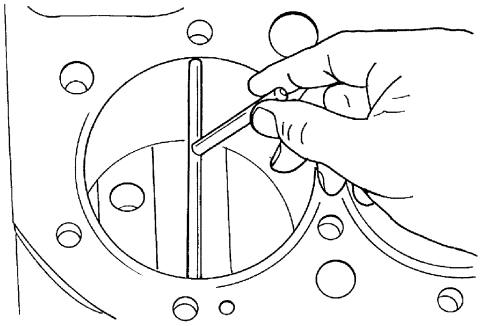
   a. Measure piston diameter 11 mm (0.433 in.) from the bottom of the skirt at a right angle to the piston pin bore as shown.



72624

**Measuring Piston Diameter**

   b. Measure cylinder bore diameter with a telescope gauge 64 mm (2-1/2 in.) from top of cylinder bore at 90 degrees from crankshaft centerline as follows.



72386

**Measuring Cylinder Bore**

| **Description** | | **4.3 liter (262 cid)** |
|---|---|---|
| Diameter | | 101.618-101.643 mm (4.0007-4.0017 in.) |
| Out Of Round | Production | 0.0127 mm (0.0005 in.) Maximum |
| | Service | 0.05 mm (0.0020 in.) Maximum |
| Taper | Production - Thrust Side | 0.012 mm (0.0005 in.) Maximum |
| | Production - Relief Side | 0.025 mm (0.0010 in.) Maximum |
| | Service | 0.025 mm (0.0010 in.) Over Production |

c. Subtract piston diameter from cylinder bore diameter to determine piston-to-bore clearance.

d. Replace the piston if the piston bore clearance is less than specified. Refer to Crankshaft, Main Bearings and Engine Block for cylinder reconditioning and piston replacement.

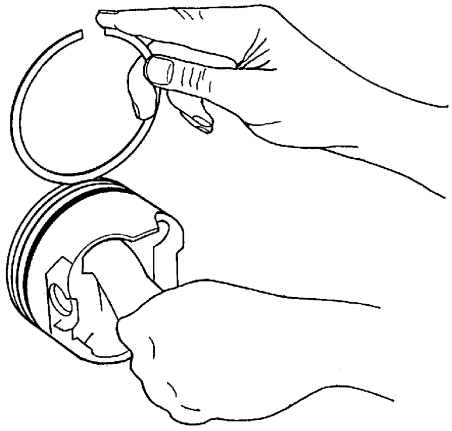
**Piston-Bore Clearance**

| Description | 4.3 liter (262 cid) |
|---|---|
| Production | 0.018-0.061 mm (0.0007-0.0024 in.) |
| Service | 0.075 mm Maximum (0.0029 in. Maximum) |

9. Insert edge of rings into respective piston ring groove and roll ring entirely around the groove to ensure that ring moves freely.

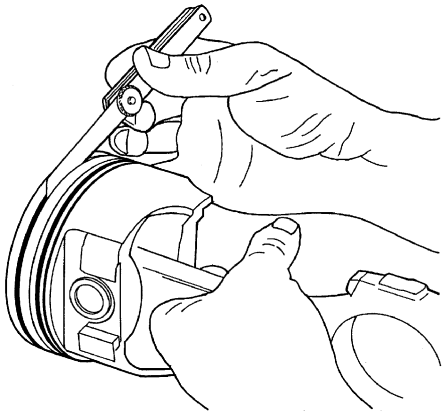
**IMPORTANT: Do not remove excess material in the following step. Verify with feeler gauge and compare to specifications.**

a. If binding occurs at any point, determine cause. If caused by ring groove, remove by dressing with a fine cut file. If binding is caused by a distorted ring, recheck with another ring.



72366

10. Using a feeler gauge, measure the clearance between the piston ring and the piston ring groove at several points around the piston.



72367

**Measuring Ring Groove Clearance**

**Top Compression**

| Description | | 4.3 liter (262 cid) |
|---|---|---|
| Groove Clearance | Production | 0.030-0.070 mm (0.0012-0.0028 in.) |
| | Service | 0.030-0.085 mm (0.0012-0.0033 in.) |

**Second Compression**

| Description | | 4.3 liter (262 cid) |
|---|---|---|
| Groove Clearance | Production | 0.040-0.080 mm (0.0015-0.0031 in.) |
| | Service | 0.030-0.085 mm (0.0012-0.0033 in.) |

**Oil Control**

| Description | | 4.3 liter (262 cid) |
|---|---|---|
| Groove Clearance | Production | 0.046-0.196 mm (0.0018-0.0079 in.) |
| | Service | 0.046-0.200 mm (0.0018-0.0079 in.) |

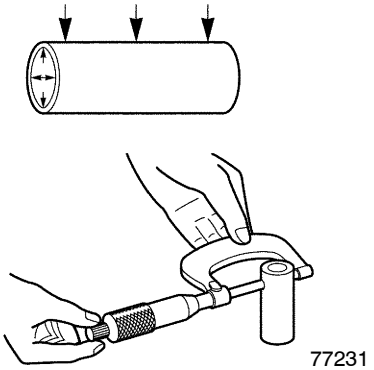
11. Replace piston if groove clearance exceeds the specified limit.

## PISTON PINS

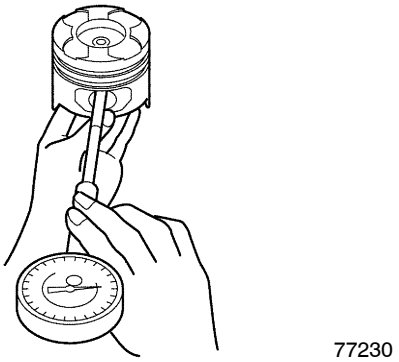
**IMPORTANT: Piston pin clearance is designed to maintain adequate clearance under all engine operating conditions. Because of this, piston and piston pin are a matched set and not serviced separately.**

***NOTE:*** *Piston pin bores and piston pins must be free of varnish and scuffing when measured.*

1. Inspect piston pin bores and piston pins for wear.
   a. Measure piston pin with a micrometer.
   b. Measure piston pin bore with a dial bore gauge or inside micrometer.




**Measuring Piston Pin**




**Measuring Piston Pin Bore**

   c. Subtract piston pin diameter from piston pin bore diameter to determine clearance.

| **Description** | | **4.3 liter (262 cid)** |
|---|---|---|
| Diameter | | 23.545-23.548 mm (0.9270-0.9271 in.) |
| Clearance | Production | 0.013-0.023 mm (0.0005-0.0009 in.) |
| | Service Limit | 0.025 mm Maximum (0.0010 in. Maximum) |
| Fit In Connecting Rod | | 0.012-0.048 mm (0.0005-0.0019 in.) Interference |

   d. If clearance exceeds service limit, replace piston and piston pin assembly.

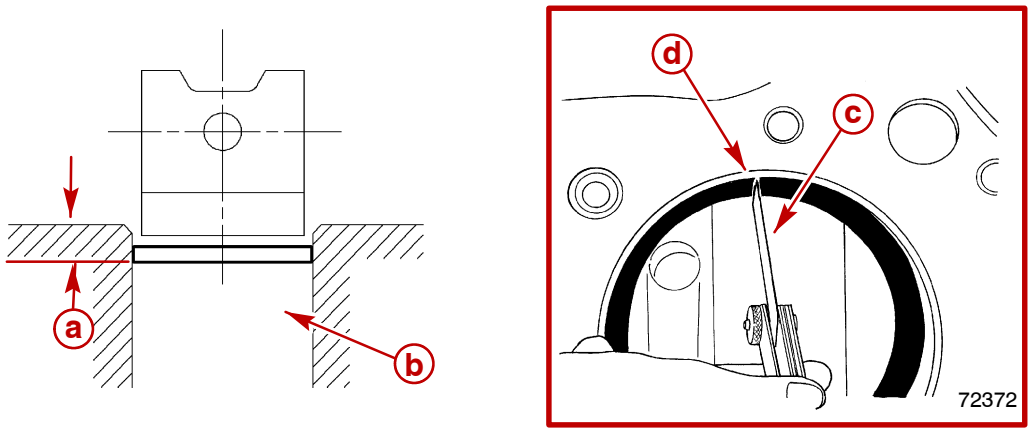
## PISTON RING GAP

**IMPORTANT: Fit each compression ring to the cylinder in which it is going to be used.**

1. Insert the piston ring into the cylinder bore.
2. Using a piston inserted upside down, push the piston ring into the cylinder bore until it reaches measuring point "**a**."

***NOTE:*** Ensure that piston ring is not slanted to one side or the other. It must be perfectly square with cylinder wall.

3. Using a feeler gauge, measure the piston ring gap.




77190

### Piston Ring Gap

**a** - Measurement Point - 6 mm (1/4 in.)
**b** - Cylinder Bore
**c** - Feeler Gauge
**d** - Ring Gap

### Top Compression

| Description | | 4.3 liter (262 cid) |
|---|---|---|
| Gap | Production | 0.25-0.40 mm (0.010-0.016 in.) |
| | Service | 0.25-0.40 mm (0.010-0.020 in.) |

**Second Compression**

| Description | | 4.3 liter (262 cid) |
|---|---|---|
| Gap | Production | 0.46-0.66 mm (0.018-0.026 in.) |
| | Service | 0.46-0.90 mm (0.018-0.035 in.) |

**Oil Control**

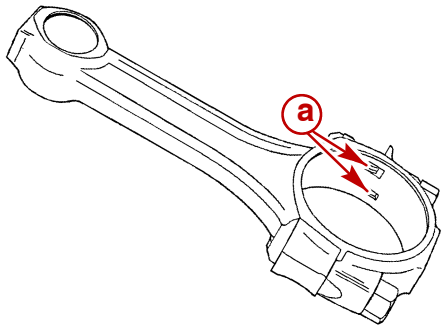
| Description | | 4.3 liter (262 cid) |
|---|---|---|
| Gap | Production | 0.25-0.76 mm (0.0098-0.030 in.) |
| | Service | 0.25-0.89 mm (0.0098-0.035 in.) |

4. Replace ring if gap exceeds service limits. If gap between ends of ring is below specifications, remove ring and try another.

# Reassembly

**IMPORTANT: When reassembling pistons and connecting rods, the following must be kept in mind.**

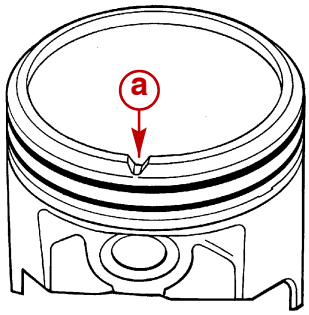
- **Piston and pin are machine fitted to each other and must remain together as a matched set. Do not intermix pistons and pins.**
- **If original pistons and/or connecting rods are being used, be sure to assemble pistons and connecting rods so they can be reinstalled in same cylinder from which they were removed.**
- **Connecting rod bearing tangs are always toward outside of engine block.**




72368

**a -** Connecting Rod Bearing Tangs

- **Notch on the piston must be positioned toward the front of the engine (water pump end).**

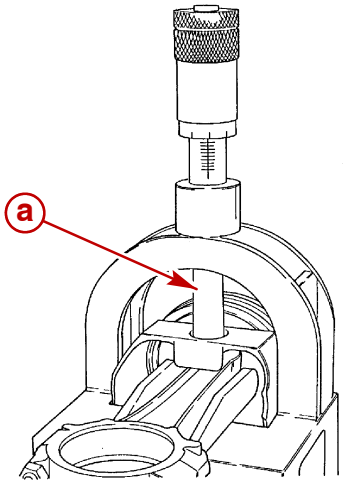



72369

**a -** Notch

## PISTON

1. Assemble piston to connecting rod using piston pin remover. Follow tool manufacturer's instructions.




72371

**a** - Piston Pin Remover (J24086-B)

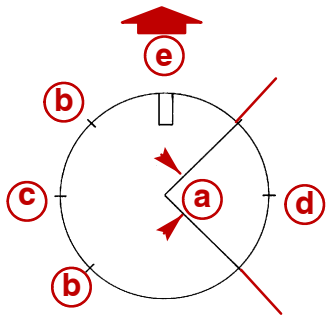
2. Once assembled, check piston for freedom of movement (back and forth, up and down) on connecting rod. Piston should move freely in all directions. If it does not, piston pin bore is tight and piston / pin assembly must be replaced.
3. If a new connecting rod has been installed, mark connecting rod and cap (on side of rod and cap with slots for connecting rod bearing tangs) with cylinder number in which it will be installed.

## PISTON RINGS

All compression rings are marked on upper side of ring. When installing compression rings, ensure that marked side is toward top of piston.

Oil control rings are a three-piece type, consisting of two rings and a spacer.

1. Select rings comparable in size to cylinder bore and piston size.
2. Install piston rings as follows:
   a. Install oil control ring spacer in groove.
   b. Hold spacer ends together and install lower oil control piston ring with gap properly located.
   c. Install upper oil control piston ring with gap properly located.
   d. Flex the oil ring assembly to ensure that the ring is free. If binding occurs at any point, determine the cause. If binding is caused by ring groove, remove by dressing groove with a fine cut file. If binding is caused by a distorted ring, use a new ring.




72373

**Ring Gap Location**

**a** - Oil Ring Spacer Gap
**b** - Oil Ring Rail Gaps
**c** - Lower Compression Ring Gap
**d** - Upper Compression Ring Gap
**e** - Engine Front

**IMPORTANT: Use piston ring expander (91-24697) for compression ring installation.**

e. Using ring expander, install lower compression ring with marked side up.
f. Using ring expander, install upper compression ring with marked side up.

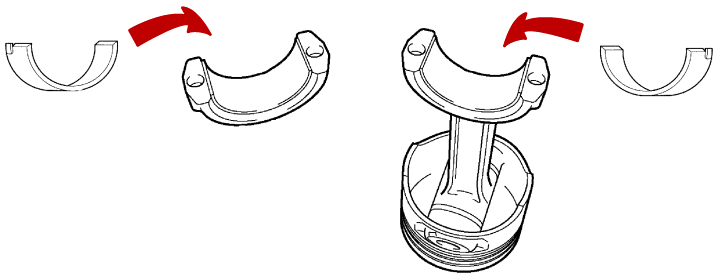
# Installation

**IMPORTANT: Cylinder bores must be clean before piston installation.**

1. Clean cylinder bores with a light honing, as necessary. Then clean with hot water and detergent wash. After cleaning, lightly lubricate bores several times with light engine oil and clean cloth, then wipe with a clean dry cloth.
2. Rotate the crankshaft until the crankpin is at before dead center (BDC) for cylinder that is ready for first piston to be installed.
3. Carefully wipe any foreign material from the connecting rod bearings and the connecting rod bearing fitting surfaces.

***NOTE:*** *Do not apply engine oil to the bearing back faces and the connecting rod bearing fitting surfaces.*

4. Insert bearing shells into connecting rod and matching rod cap.

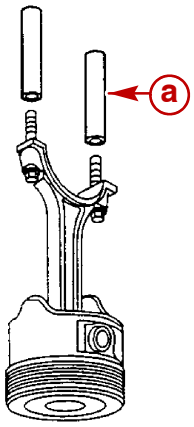


77251

5. Lubricate connecting rod bearings, pistons, rings and cylinder walls.

| Description | Where Used | Part Number |
|---|---|---|
| Engine Oil | Connecting rod bearings, pistons, rings and cylinder walls | Obtain Locally |

6. With bearing caps removed, install connecting rod bolt guides on connecting rod bolts. It is acceptable to use clean rubber tubing for the connecting rod bolt guides.

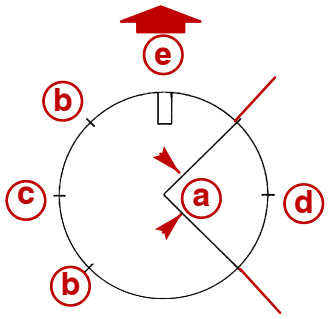



76719

**a** - Connecting Rod Bolt Guide (J5239)

**IMPORTANT: Ensure ring gaps are properly positioned.**

7. Position ring gaps as shown.

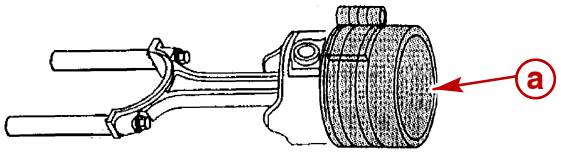



72373

**Ring Gap Location**

**a** - Oil Ring Spacer Gap
**b** - Oil Ring Rail Gaps
**c** - Lower Compression Ring Gap
**d** - Upper Compression Ring Gap
**e** - Engine Front

8. Use piston ring compressor and compress rings.



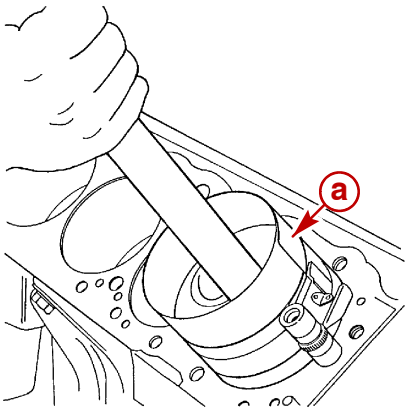

00000

**a** - Piston Ring Compressor (J8037)

**IMPORTANT: Be sure to install new pistons in same cylinders for which they were fitted and used pistons in same cylinder from which they were removed. Each connecting rod and bearing cap should be marked, beginning at front of engine (1, 3, 5 and 7 in left bank and 2, 4, 6 and 8 in right bank). Numbers on connecting rod and bearing cap must be on same side when installed in cylinder bore. If a connecting rod is ever transposed from one block or cylinder to another, new bearings should be fitted and connecting rod should be numbered to correspond with new cylinder number.**

9. Install each connecting rod and piston assembly in its respective bore with connecting rod bearing tangs toward outside of engine block and piston notch toward front of engine.
10. Guide connecting rod into place on crankshaft journal with connecting rod bolt guide.
11. Hold ring compressor firmly against engine block until all piston rings have entered cylinder bore.

12. Using a wooden or plastic hammer handle, lightly tap the piston into bore.




72374

**a** - Piston Ring Compressor (J8037)

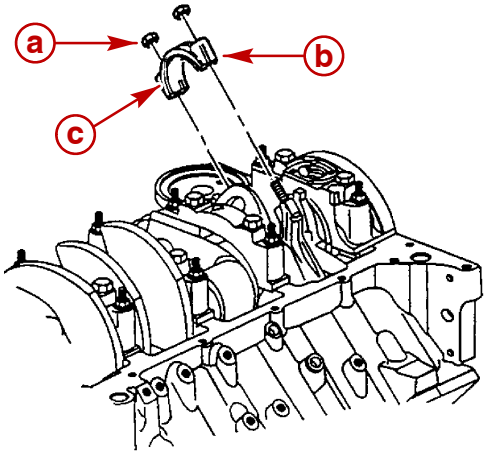
13. Remove connecting rod bolt guides.
14. Apply a coat of engine oil to the threads and mating faces of each connecting rod cap, bolt and nut.

| Description | Where Used | Part Number |
|---|---|---|
| Engine Oil | Connecting rod and rod cap | Obtain Locally |

**⚠ CAUTION**

**The connecting rod caps MUST be installed in the correct direction. Reversing the cap direction will result in serious engine damage.**

15. Install the connecting rod cap.



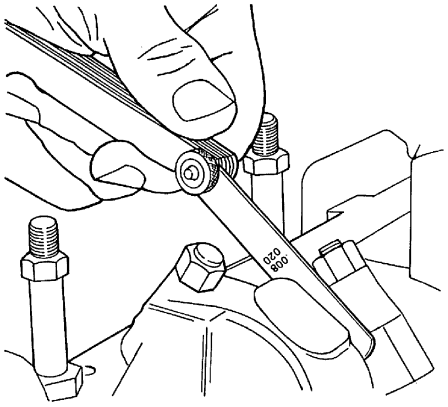

76716

**a** - Connecting Rod Nuts
**b** - Connecting Rod Caps
**c** - Lower Bearing

16. In a two pass sequence, torque connecting rod cap nuts.

| Description | | Nm | lb-in. | lb-ft |
|---|---|---|---|---|
| Connecting Rod Nut - 4.3 liter (262 cid) | | | | |
| | First Pass | 27 | | 20 |
| | Final Pass (Angle Torque) | + 70 degrees | | |

17. Lightly tap each connecting rod assembly parallel to the crankpin to ensure clearance.
18. Measure all connecting rod side clearances between connecting rod caps.



72363

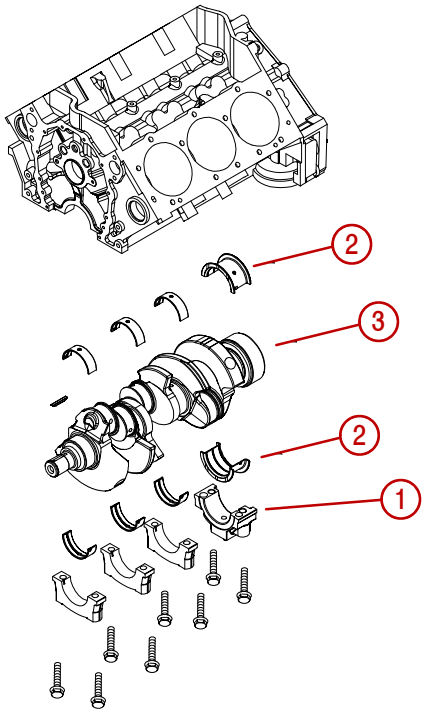
**Measuring Connecting Rod Side Clearance**

| Description | 4.3 liter (262 cid) |
|---|---|
| Rod Side Clearance | 0.15-0.44 mm (0.0059-0.017 in.) |

19. Install oil pump and crankshaft oil deflector.
20. Install dipstick and oil pan.
21. Install cylinder heads.
22. Install intake manifold assembly.
23. Install distributor.
24. Adjust valves.
25. Install valve covers.
26. Install exhaust elbow and manifold assemblies.
27. Fill crankcase with proper viscosity and quantity of oil. Refer to SECTION 1B.
28. Install all components removed from the front of the engine.

# Crankshaft, Main Bearings And Engine Block

## Exploded View




78253

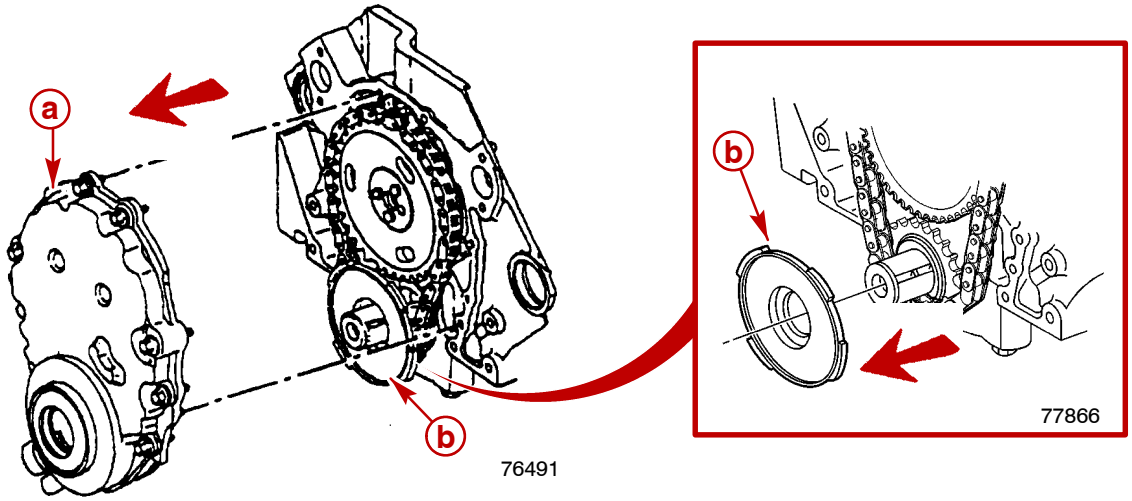
**1** - Main Bearing Cap
**2** - Main Bearings
**3** - Crankshaft

## Removal

| NOTICE |
| --- |
| **If only the main bearings are being serviced refer to Installation - Bearings Without Crankshaft Removed.** |

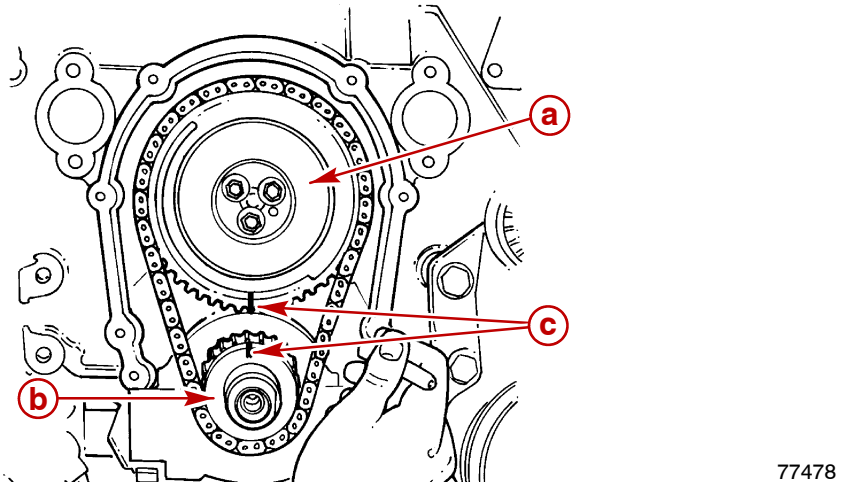
1. Remove sterndrive unit.
2. Remove engine from boat.
3. Drain crankcase oil.
4. Remove starter.
5. Remove flywheel housing.
6. Remove coupler / drive plate.
7. Remove flywheel.
8. Remove belt.
9. Remove water circulating pump.
10. Remove crankshaft pulley and crankshaft balancer.
11. Remove spark plugs.
12. Remove dipstick tube and oil pan.
13. Remove crankshaft oil deflector and oil pump.
14. Remove crankshaft position sensor. Discard O-ring seal.

15. Remove engine front cover.
16. Remove the crankshaft position sensor reluctor ring.



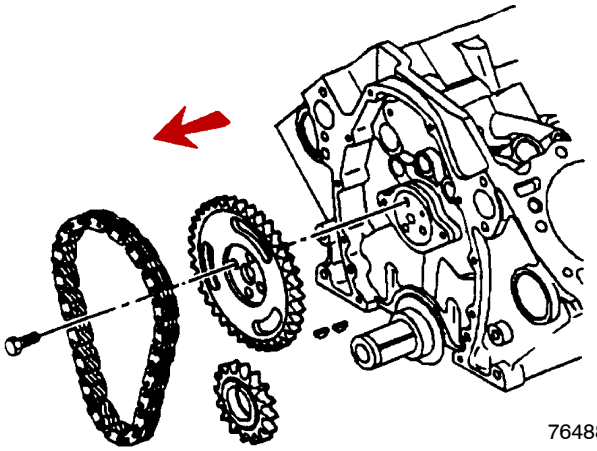

**a** - Front Cover
**b** - Reluctor Ring

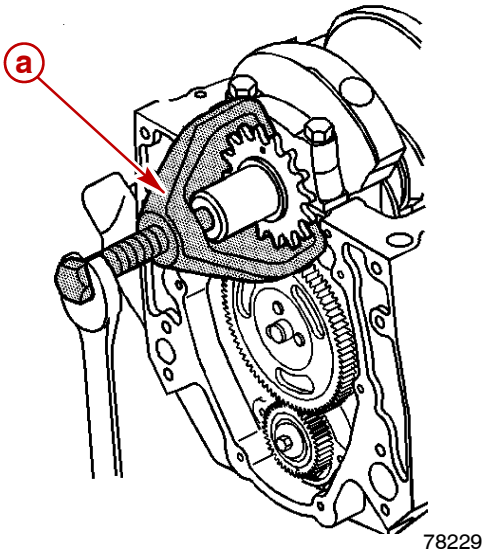
17. Turn crankshaft to align timing mark with camshaft mark or turn crankshaft to cylinder number 1 TDC and mark both gears for alignment in reassembly.




**a** - Camshaft Gear
**b** - Crankshaft Gear
**c** - Alignment Marks

18. Remove camshaft sprocket.
19. Remove timing chain.
20. Remove crankshaft sprocket with J5285-A.


76488



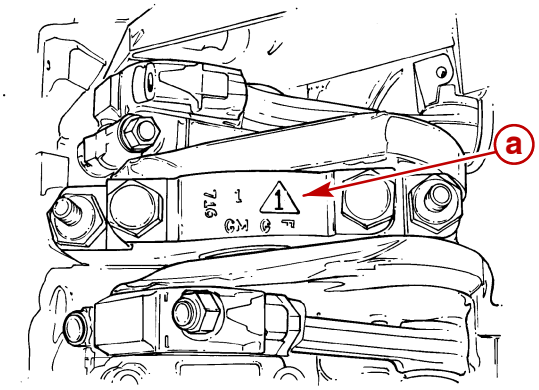
78229

**a** - Crankshaft Sprocket Remover (J5285-A)

21. Remove rear main seal and retainer.
22. Remove connecting rod and piston assemblies.

**IMPORTANT: Inspect bearing caps for orientation marks prior to removal. If no markings exist, make suitable marks before disassembly so that they can be reinstalled in their original locations.**

23. Ensure that all bearing caps are marked so that they can be reinstalled in their original locations.

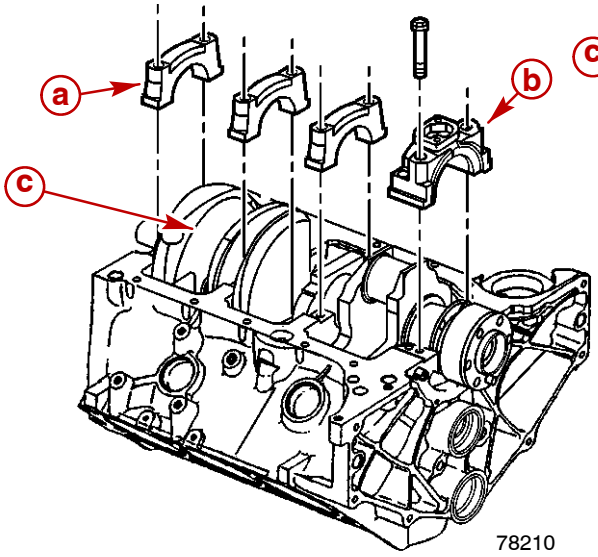


77467

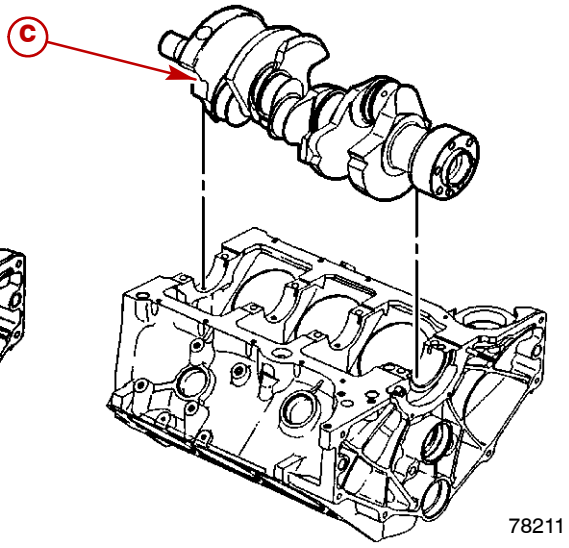
**Typical**

**a** - Bearing Cap Mark

24. Remove main bearing caps and carefully lift crankshaft out of engine block.



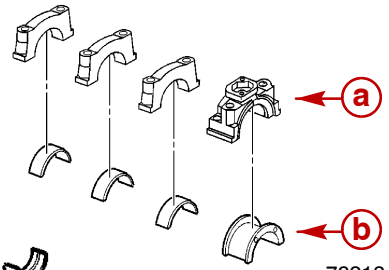
78210



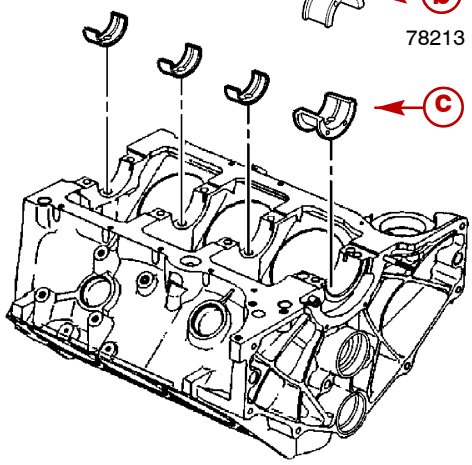
78211

**a** - Main Bearing Cap
**b** - Rear Main Bearing Cap
**c** - Crankshaft

25. If new main or connecting rod bearings are to be installed, remove main bearing inserts from engine block and bearing caps or connecting rod bearing inserts from connecting rod and caps. Install new bearings.



78213



78212

**a** - Main Bearing Caps
**b** - Upper Bearing Insert
**c** - Lower Bearing Insert

# Cleaning

## CRANKSHAFT

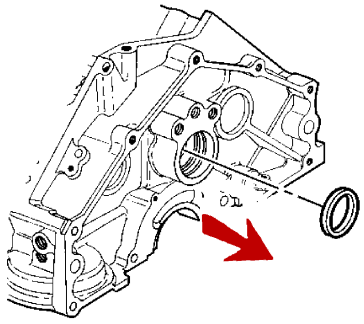
1. Put on safety glasses.
2. Clean the crankshaft in cleaning solvent. Ensure oil passages are clear of all sludge and restrictions.
3. Dry part with compressed air.

## MAIN BEARINGS

4. Put on safety glasses.
1. Clean the crankshaft bearings in cleaning solvent. Wipe the crankshaft bearings clean with a soft cloth, do not scratch the crankshaft bearing surfaces.
2. Dry parts with compressed air.

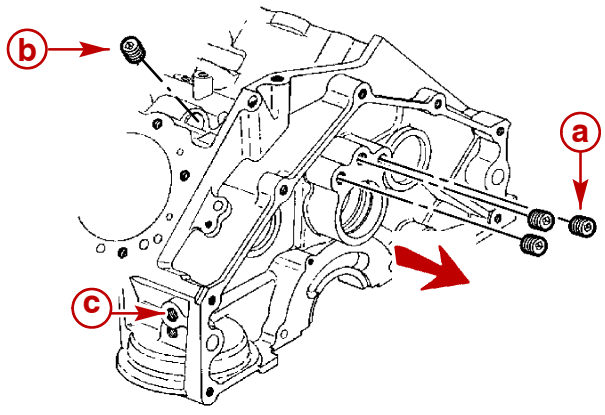
## ENGINE BLOCK

1. Remove all engine components.
2. Remove the camshaft rear bearing hole expansion cup plug.



77893

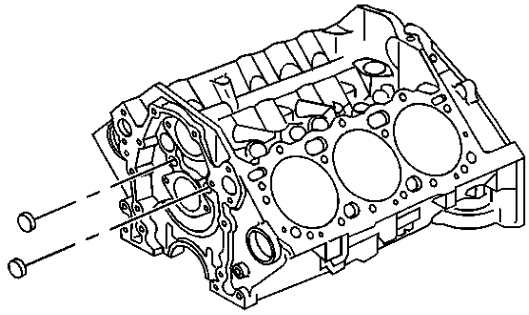
3. Remove oil pressure sender and oil gallery plugs indicated.




77895

**a** - Rear Oil Gallery Plugs
**b** - Left Rear Top Oil Gallery Plug
**c** - Oil Pressure Sender Location

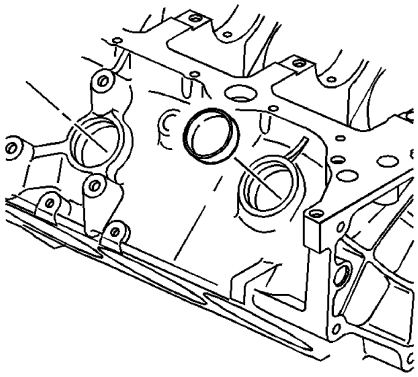
4. Put on safety glasses.
5. Insert a 3/8 in. x 26 in. rod into rear oil gallery holes and drive out (remove) oil gallery plugs at front of engine block. Discard plugs.



78247

6. Remove engine block core hole expansion plugs.

***NOTE:*** *These plugs may be removed with a sharp punch or they may be drilled and pried out.*



78231

7. Clean all sealing surfaces.
8. Remove sealant residue.
9. Clean the engine block with cleaning solvent.
10. Flush the engine block with clean water or steam clean.

11. Clean the cylinder bores.
12. Clean the oil galleries and oil passages.
13. Clean scale and deposits from coolant passages.

**⚠ CAUTION**

**Avoid engine damage. Clean all debris, dirt and coolant from the engine block cylinder head bolt holes. Failure to remove all foreign material may result in damaged threads, improperly tightened fasteners or damage to the engine.**

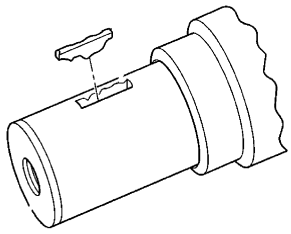
14. Clean the engine block cylinder head bolt holes and dry with compressed air.
15. After cleaning the engine block, spray or wipe the cylinder bores and the machined surfaces with clean engine oil.

| Description | Where Used | Part Number |
|---|---|---|
| Engine Oil | Cylinder bores and the machined surfaces | Obtain Locally |

## Inspection

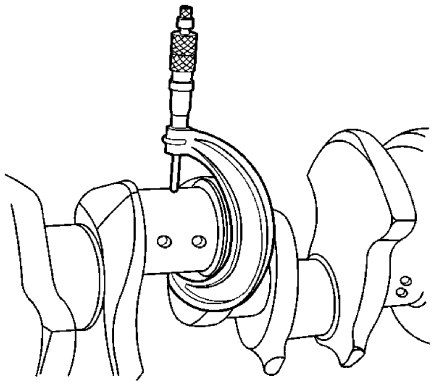
### CRANKSHAFT

1. Inspect crankshaft for deep grooves, scratches, pitted surfaces or uneven wear.
2. Inspect crankshaft rear oil seal surface for scoring or damage.
3. Inspect crankshaft oil passages for restrictions.
4. Inspect the thrust journal surface wear or damage.
5. Inspect the crankshaft threaded bolt hole for damage.
6. Inspect the crankshaft balancer keyway for damage.



78203

7. Measure the main bearing journals with a micrometer for out-of-round, taper or undersize.



78200

***NOTE:*** *Measure the crankshaft journal diameter in several places, approximately 90 degrees apart, and average the measurements.*

| Description | | 4.3 liter (262 cid) |
|---|---|---|
| Diameter | Number 1 | 62.199-62.217 mm (2.4488-2.4495 in.) |
| | Number 2, 3 | 62.191-62.215 mm (2.4485-2.4494 in.) |
| | Number 4 | 62.179-62.203 mm (2.4480-2.4489 in.) |

| Description | | 4.3 liter (262 cid) |
|---|---|---|
| Taper | Production | 0.007 mm (0.0003 in.) Maximum |
| Out of Round | Production | 0.005 mm (0.0002 in.) Maximum |
| | Service | 0.025 mm (0.0010 in.) Maximum |

8. Measure connecting rod bearing journals with a micrometer for out of round, taper or undersize.

| Description | | 4.3 liter (262 cid) |
|---|---|---|
| Diameter | | 57.116–57.148 mm (2.2487-2.2497 in.) |
| Taper | Production | 0.00508 mm (0.0003 in.) Maximum |
| | Service Limit | 0.025 mm (0.0010 in.) Maximum |
| Out of Round | Production | 0.007 mm (0.0003 in.) Maximum |
| | Service | 0.025 mm (0.0010 in.) Maximum |

9. To check crankshaft for runout, support at the front and rear main bearings journals in V-blocks.
10. Check at front and rear intermediate journals with a dial indicator.

| Description | 4.3 liter (262 cid) |
|---|---|
| Runout | 0.025 mm (0.0010 in.) |

11. Replace or recondition crankshaft if not within specifications.

## MAIN BEARINGS

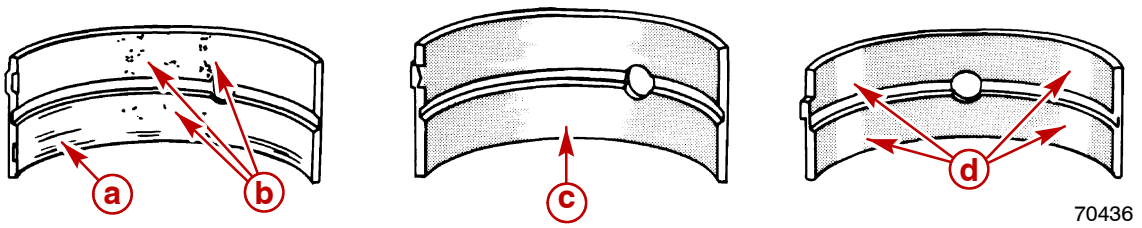
Main bearings are of the precision insert type and do not use shims for adjustment. If clearances are excessive, a new bearing, both upper and lower halves, will be required. Service bearings are available in standard size and .0254 mm(.001 in.), .254 mm (.010 in.) and .508 mm (.020 in.) undersize.

Selective fitting of both rod and main bearing inserts is necessary in production to obtain close tolerances. For this reason you may find 1/2 of a standard insert with 1/2 of a .0254 mm (.001 in.) undersize insert, which will decrease the clearance .0127 mm (.0005 in.) from using a full standard bearing.

When a production crankshaft cannot be precision fitted by this method, it is then ground .229 mm (.009 in.) undersize, ON ONLY THOSE MAIN JOURNALS THAT CANNOT BE PROPERLY FITTED. ALL JOURNALS WILL NOT NECESSARILY BE GROUND UNDERSIZE. A .229 mm (.009 in.) undersize bearing and .254 mm (.010 in.) undersize bearing may be used for precision fitting in the same manner as previously described.

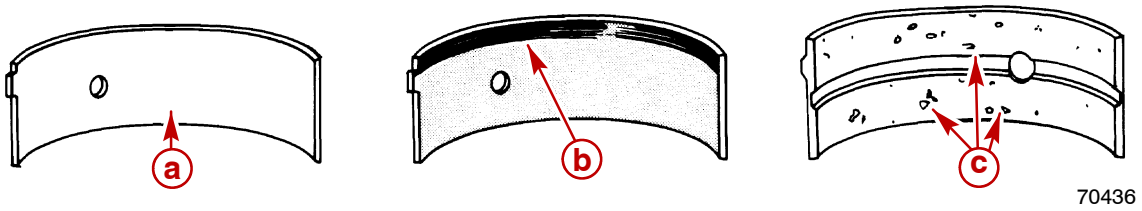
In general, the lower half of the bearing (except number 1 bearing) shows a greater wear and the most distress from fatigue. If upon inspection the lower half is suitable for use, it can be assumed that the upper half is also satisfactory. If the lower half shows evidence of wear or damage, replace both upper and lower halves. Never replace one half without replacing the other half.

**Examples of Bearing Failures**




**Scratched By Dirt** **Lack Of Oil** **Improper Seating**

**a** - Scratches
**b** - Dirt Imbedded Into Bearing Material
**c** - Overlay Wiped Out
**d** - Bright (Polished) Sections

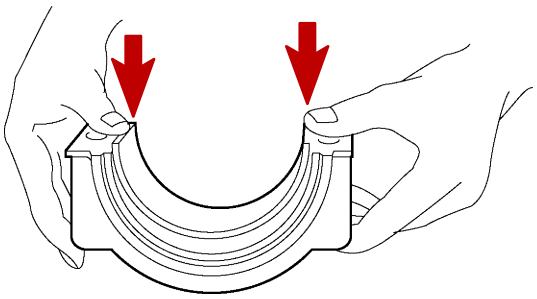



**Tapered Journal** **Radius Ride** **Fatigue Failure**

**a** - Overlay Gone From Entire Surface
**b** - Radius Ride
**c** - Craters Or Pockets

## MAIN BEARING TENSION

1. Ensure that the main bearing installs under tension. It should require firm pressure to fit the bearing into position.



77214

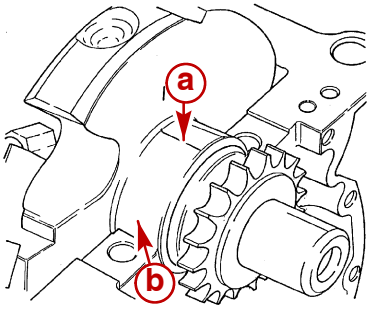
**Main Bearing Tension**

## MAIN BEARING CLEARANCE - GAUGING PLASTIC METHOD

To obtain accurate measurements while using Plastigage or its equivalent, engine must be out of the boat and upside down so crankshaft will rest on the upper bearings and total clearance can be measured between lower bearing and journal.

To assure the proper seating of the crankshaft, all bearing cap bolts should be at their specified torque. In addition, preparatory to checking fit of bearings, the surface of the crankshaft journal and bearing should be wiped clean of oil.

1. Remove bearing cap and wipe oil from journal and bearing cap to be inspected.
2. Place a piece of gauging plastic the full width of the bearing, parallel to the crankshaft journal as shown.




72357

**a** - Gauging Plastic
**b** - Journal

**⚠ CAUTION**

**Avoid incorrect measurements. Bearing cap MUST be torqued to specification to ensure correct measurements. Variations in torque affect the compression of the plastic gauge. Do not rotate the crankshaft while the gauging plastic is between the bearing and journal.**

3. Install the bearing cap and evenly torque the main bearing cap bolt or stud to specifications.

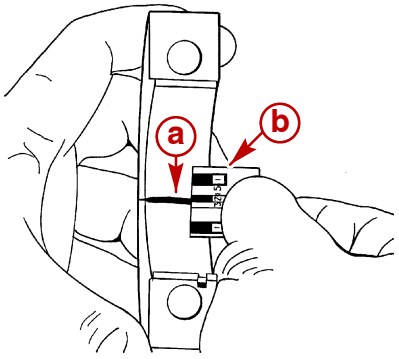
| Description | | Nm | lb-in. | lb-ft |
|---|---|---|---|---|
| Crankshaft Main Bearing Cap Bolt and Stud - Preferred Method | | | | |
| Two Bolt Type Cap | First Pass | 20 | | 15 |
| | Final Pass | + 73 degrees | | |
| Crankshaft Main Bearing Cap Bolt and Stud - Optional Method | | | | |
| Two Bolt Type Cap | One Pass - All Bolts Evenly Tightened | 105 | | 77 |

4. Remove bearing cap. The flattened gauging plastic will be found adhering to either the bearing cap or journal.

5. On the edge of the gauging plastic envelope there is a graduated scale that is correlated in thousandths of an inch. Without removing the gauging plastic, measure its compressed width (at the widest point) with the graduated scale.

***NOTE:*** *Normally main bearing journals wear evenly and are not out of round.*

- *if a bearing is being fitted to an out of round journal of .0254 mm (.001 in.) maximum, be sure to fit to the maximum diameter of the journal.*
- *If the bearing is fitted to the minimum diameter and the journal is out of round .0254 mm (.001 in.), interference between the bearing and journal will result in rapid bearing failure.*
- *If the flattened gauging plastic tapers toward the middle or ends, there is a difference in clearance indicating taper, low spot or other irregularity of the bearing or journal.*
- *Measure the journal with a micrometer if the flattened gauging plastic indicates more than .0254 mm (.001 in.) difference.*




72358

**a** - Compressed Gauging Plastic
**b** - Graduated Scale

### Main Bearing Clearance

| Description | | 4.3 liter (262 cid) |
|---|---|---|
| Production | Number 1 | 0.018-0.053 mm (0.0007-0.0021 in.) |
| | Number 2, 3, 4 | 0.030-0.068 mm (0.0012-0.0027 in.) |
| | Number 5 | 0.020-0.060 mm (0.0008-0.0024 in.) |
| Service | Number 1 | 0.025-0.051 mm (0.0010-0.0020 in.) |
| | Number 2, 3, 4 | 0.025-0.064 mm (0.0010-0.0025 in.) |
| | Number 5 | 0.038-0.063 mm (0.0015-0.0025 in.) |

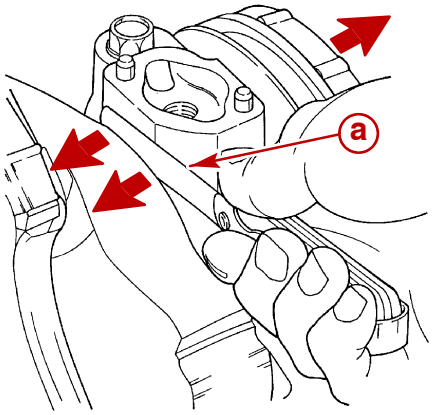
6. If the bearing clearance is within specifications, the bearing insert is satisfactory. If the clearance is not within specifications, replace the insert. Always replace both upper and lower inserts as a unit.
7. A standard or 0.025 mm (0.001 in.) undersize bearing may produce the proper clearance. If not, it will be necessary to regrind the crankshaft journal for use with the next undersize bearing.

**IMPORTANT: After selecting new bearing, recheck clearance.**

8. Check clearance with newly selected bearing. If the bearing clearance is within specifications, the bearing insert is satisfactory. If not, repeat previous steps.
9. Proceed to the next bearing. After all bearings have been checked, rotate the crankshaft to check for excessive drag. When checking number 1 main bearing, loosen accessory drive belts to prevent tapered reading with plastic gauge.

## CRANKSHAFT END PLAY

1. Firmly force the crankshaft rearward.
2. Firmly force the crankshaft forward.
3. Measure clearance at the front end of the rear main bearing with a feeler gauge as shown.



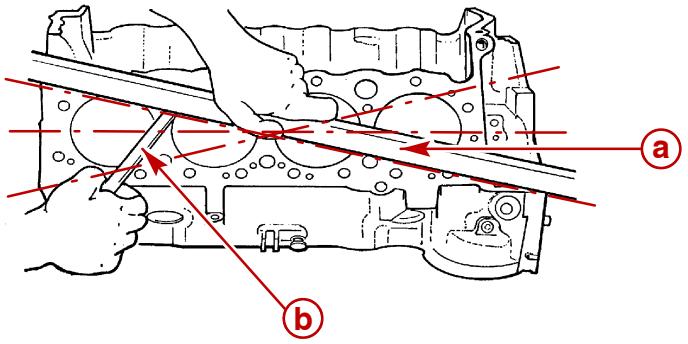

72360

**a** - Feeler Gauge

| Description | 4.3 liter (262 cid) |
|---|---|
| End Play (Thrust Clearance) | 0.05-0.20 mm (0.0020-0.0079 in.) |

## ENGINE BLOCK

1. Inspect the engine block for cracks in coolant jackets.
2. Inspect the cylinder bores for scratches or gouging.
3. Inspect the valve lifter bores for excessive scoring or wear.
4. Inspect the threaded holes, crankshaft bearing caps, bearing bores and engine block core hole expansion plug bores for damage.
5. Inspect the engine block, engine mount bosses and crankshaft bearing webs for cracks or damage.
6. Check engine block head gasket surfaces for warp with a machinist's straight-edge and a feeler gauge. Take measurements diagonally across surfaces (both ways) and straight down center. If surfaces are warped more than specified, engine block must be resurfaced by a machine shop.




72388

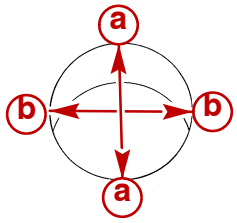
**a** - Machinist's Straight-Edge
**b** - Feeler Gauge

| Description | | 4.3 liter (262 cid) |
|---|---|---|
| Cylinder head gasket surface flatness | Within An 152 mm (6 in.) Area | 0.10 mm (0.0040 in.) |

7. Measure cylinder walls for taper, out of round or excessive ridge at top of ring travel. This should be done with a dial indicator or inside micrometer. Carefully move gauge up and down cylinder to determine taper. Turn gauge to different points around cylinder wall to determine out of round condition.

Taper = Difference between measurement "**a**" at top of cylinder bore and "**a**" measurement at bottom of cylinder bore

Out of Round = Difference between "**a**" and "**b**"



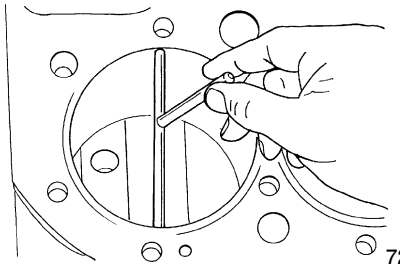

72385

**Cylinder Measurement Points**

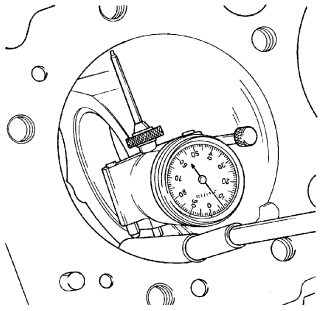
**a** - At Right Angle To Centerline Of Engine
**b** - Parallel To Centerline Of Engine

| Description | 4.3 liter (262 cid) |
|---|---|
| Diameter | 94.894-94.947 mm (3.7360-3.7381 in.) |

8. If cylinder bore exceeds specifications, boring and/or honing will be necessary.



72386



72387

**Methods Of Measuring Cylinder Bore**

| Description | | 4.3 liter (262 cid) |
|---|---|---|
| Out Of Round | Production | 0.0127 mm (0.0005 in.) Maximum |
| | Service | 0.05 mm (0.0020 in.) Maximum |
| Taper | Production - Thrust Side | 0.012 mm (0.0005 in.) Maximum |
| | Production - Relief Side | 0.025 mm (0.0010 in.) Maximum |
| | Service Limit | 0.025 mm (0.0010 in.) Over Production |

## CYLINDER RECONDITIONING

***NOTE:*** *Performance of the following operation depends upon engine condition at time of repair.*

***NOTE:*** *If engine block inspection indicates that the block is suitable for continued use, out of round or tapered cylinders can be reconditioned by honing or boring.*

1. If cylinders have less than 0.127 mm (0.0050 in.) taper or wear, they can be conditioned with a hone and fitted with high limit standard size piston. A cylinder bore of more than 0.127 mm (0.0050 in.) wear or taper may not clean up entirely when fitted to a high limit piston. To entirely clean up the bore, it will be necessary to bore for an oversize piston. If more than 0.127 mm (0.0050 in.) taper or wear, bore and hone to smallest oversize that will permit complete resurfacing of all cylinders.
2. When pistons are being fitted and honing is not necessary, cylinder bores may be cleaned with a hot water and detergent wash. After cleaning, lightly lubricate cylinder bores with engine oil and a clean cloth and then wipe with a clean dry cloth.

## CYLINDER BORING

**IMPORTANT: Before using any type of boring bar, file top of engine block to remove dirt or burrs. This prevents boring bar tilt (the bored cylinder wall is not at right angles to crankshaft.)**

1. File top of engine block to remove dirt and burrs.
2. Measure piston to be fitted with a micrometer, measuring at center of piston skirt and at right angles to piston pin. Bore cylinder to same diameter as piston and hone to give specified clearance.

***NOTE:*** *Hone cylinders as outlined under Cylinder Honing and Piston Selection, following.*

3. Carefully observe equipment manufacturer's instructions.

## CYLINDER HONING

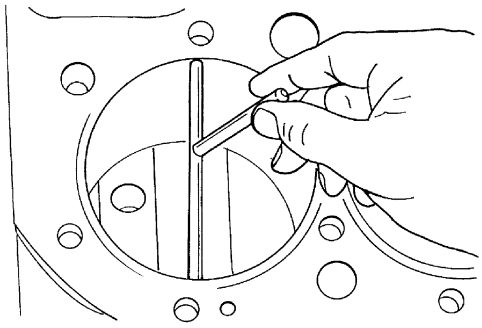
1. Follow manufacturer's instructions.
2. Occasionally, during the honing operation, clean cylinder bore and check piston for correct fit in cylinder.
3. When finish-honing a cylinder bore to fit a piston, move hone up and down at a sufficient speed to obtain very fine uniform surface finish marks in a crosshatch pattern of approximately 30 degrees to cylinder bore. Finish marks should be clean but not sharp, free from imbedded particles and torn or folded metal.
4. Permanently mark piston for cylinder to which it has been fitted (refer to Piston Selection) and proceed to hone cylinders and fit remaining pistons.

**IMPORTANT: Handle pistons with care and do not attempt to force them through cylinder until cylinder is honed to correct size, as these pistons can be distorted by careless handling.**

5. Thoroughly clean cylinder bores with hot water and detergent. Scrub with a stiff bristle brush and rinse thoroughly with hot water. It is extremely essential that a good cleaning operation be performed. If any abrasive material remains in cylinder bores, it will rapidly wear new rings, cylinder bores and bearings lubricated by the contaminated oil. lightly lubricate bores several times with light engine oil on a clean cloth, then wipe with a clean dry cloth. Cylinder should not be cleaned with kerosene or gasoline. Clean remainder of engine block to remove excess material spread during honing operation.

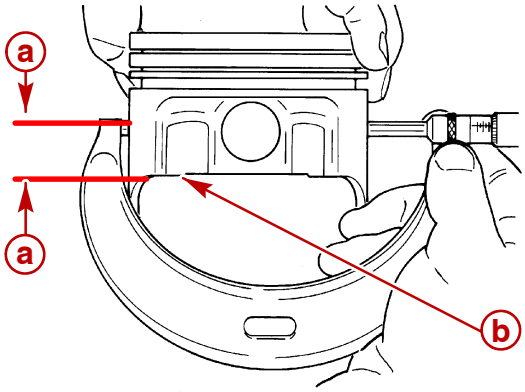
## PISTON SELECTION

1. Check used piston to cylinder bore clearance as follows:
   a. Measure cylinder bore diameter with a telescope gauge 64 mm (2-1/2 in.) from top of cylinder bore.



72386

   b. Measure piston diameter at skirt 11 mm (0.4331 in.) from the bottom of the skirt at a right angle to the piston pin bore.




72624

**a** - Measurement - 11 mm (0.4331 in.)
**b** - Bottom Of Skirt

   c. Subtract piston diameter from cylinder bore diameter to determine piston-to-bore clearance.
   d. Determine if piston bore clearance is in acceptable range.

**Piston Bore Clearance**

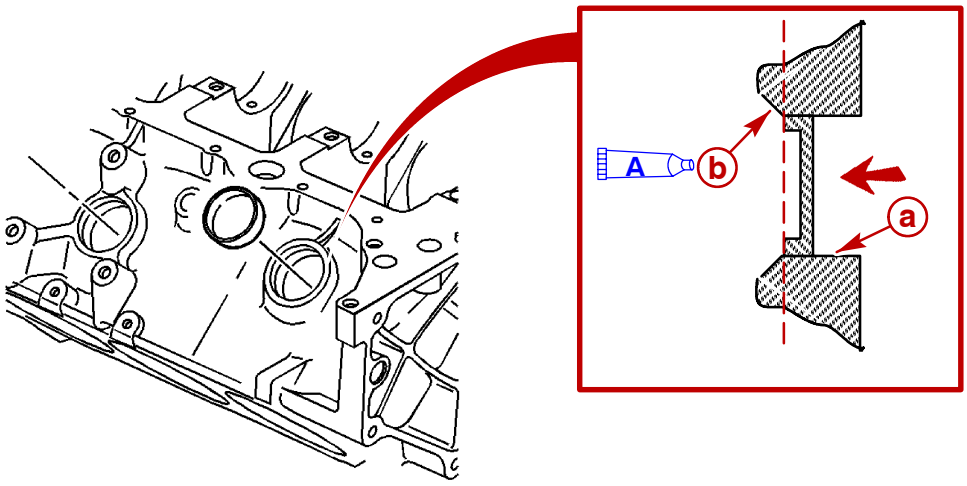
| Description | 4.3 liter (262 cid) |
|---|---|
| Production | 0.018-0.061 mm (0.0007-0.0024 in.) |
| Service | 0.075 mm Maximum (0.0029 in. Maximum) |

2. If used piston is not satisfactory, determine if a new piston can be selected to fit cylinder bore within acceptable range.
3. If cylinder bore must be reconditioned, measure new piston diameter, then hone cylinder bore to correct clearance.
4. Mark piston to identify cylinder for which it was fitted.

# Installation

## ENGINE BLOCK PLUGS

1. Put on safety glasses.
2. Apply sealant to the outside diameter of each new engine block core hole expansion plugs.
3. Install engine block core hole expansion plugs flush with the inside chamfer of the engine block core hole.

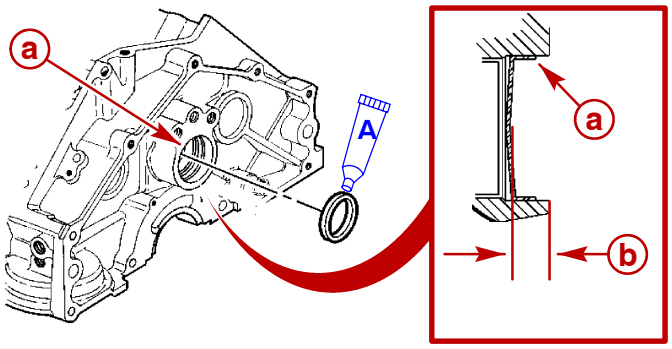



78231

**a** - Core Hole
**b** - Inside Chamfer

| Description | | Where Used | Part Number |
|---|---|---|---|
| A | Loctite 242 | Engine block core hole expansion plug | 92-809821 |

4. Apply sealant to the outside diameter of the new camshaft rear bearing hole expansion cup plug.
5. Install the camshaft rear bearing hole expansion cup plug as indicated.

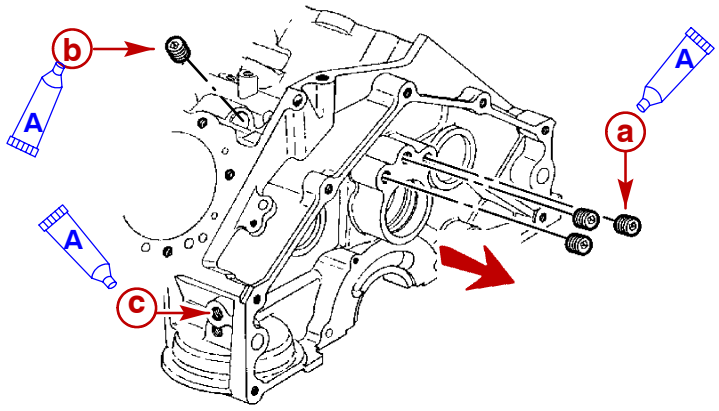



77893

**a** - Camshaft Bearing Hole
**b** - Measurement - 8.8 mm (0.3465 in.)

| Description | | Where Used | Part Number |
|---|---|---|---|
| A | Loctite 242 | Camshaft rear bearing hole expansion plug | 92-809821 |

6. Apply sealant to the threads of the oil pressure sender and oil gallery plugs.
7. Install oil pressure sender and oil gallery plugs indicated.




77895

**a** - Rear Oil Gallery Plugs
**b** - Left Rear Top Oil Gallery Plug
**c** - Oil Pressure Sender Location

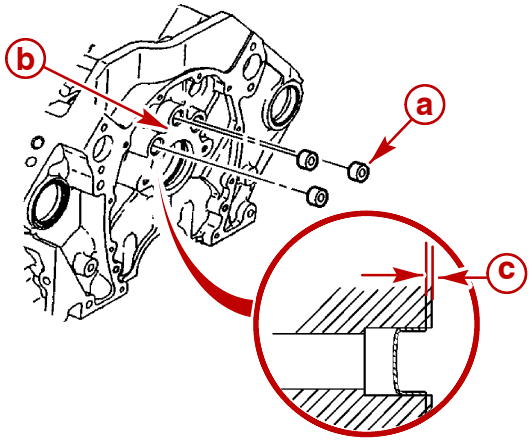
| Description | | Where Used | Part Number |
|---|---|---|---|
| A | Loctite 565 PST | Oil gallery plugs | Obtain Locally |
| | | Oil pressure sender | |

| Description | | Nm | lb-in. | lb-ft |
|---|---|---|---|---|
| 1 | Oil Gallery Plug | 20 | | 15 |

8. Coat the threads of the new engine block oil gallery plugs.

| Description | Where Used | Part Number |
|---|---|---|
| Loctite 565 PST | Oil gallery plug | Obtain Locally |

9. Install front oil gallery plugs less than flush with engine block front surface as indicated.




77892

**a** - Front Oil Gallery Plugs
**b** - Engine Block Front Surface
**c** - Measurement - 0.11 mm (0.004 in.)

10. Coat the threads of the engine block coolant drain plugs.

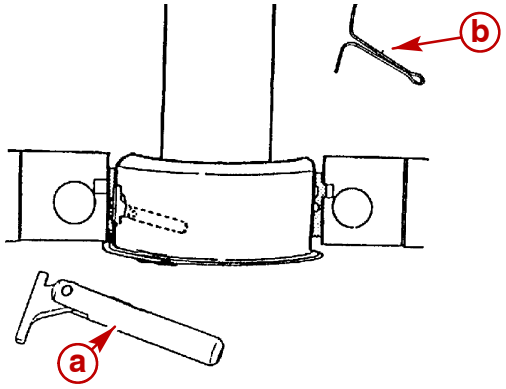
| Description | Where Used | Part Number |
|---|---|---|
| Loctite 565 PST | Engine block coolant drain hole plug | Obtain Locally |

11. Install engine block coolant drain hole plugs. Torque plugs.

| Description | Nm | lb-in. | lb-ft |
|---|---|---|---|
| Engine Block Coolant Drain Hole Plug | 20 | | 15 |

## MAIN BEARINGS - WITHOUT CRANKSHAFT REMOVED

1. Remove the cap on the main bearing requiring replacement.
2. Remove the bearing from the cap.
3. Install the main bearing remover/installer in the oil hole in the crankshaft journal. If this tool is not available, a cotter pin may be bent as shown and used.



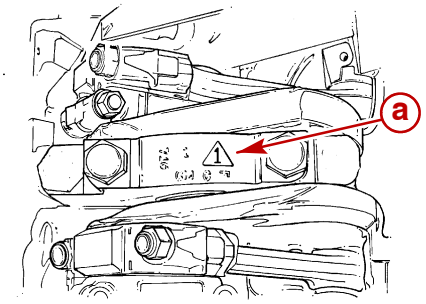

72622

**a** - Main Bearing Remover/Installer (J8080)
**b** - Cotter Pin

4. Rotate the crankshaft clockwise as viewed from the front of engine. This will roll the upper bearing out of the engine block.
5. Lubricate a new upper bearing.
6. Insert the plain (unnotched) end between the crankshaft and the indented or notched side of the engine block.
7. Rotate the bearing into place and remove the tool from the oil hole in the crankshaft journal.
8. Lubricate a new lower bearing and install in bearing cap.

| Description | Where Used | Part Number |
|---|---|---|
| Engine Oil | Upper Bearing, Lower Bearing | Obtain Locally |

9. Install the main bearing cap in the original location with the markings pointing toward the front of the engine.




77467

**a** - Bearing Cap Marking

10. Torque all main bearing caps, EXCEPT the rear main bearing cap.

| Description | | Nm | lb-in. | lb-ft |
|---|---|---|---|---|
| Crankshaft Main Bearing Cap Bolt and Stud - Preferred Method | | | | |
| Two Bolt Type Cap | First Pass | 20 | | 15 |
| | Final Pass | + 73 degrees | | |
| Crankshaft Main Bearing Cap Bolt and Stud - Optional Method | | | | |
| Two Bolt Type Cap | One Pass - All Bolts Evenly Tightened | 105 | | 77 |

11. Torque the rear main bearing cap.
    a. **Preferred Method -** Do first pass torque on rear main bearing cap.

| Description | | Nm | lb-in. | lb-ft |
|---|---|---|---|---|
| Crankshaft (Main) Bearing Cap Bolt and Stud - Preferred Method | | | | |
| Two Bolt Type Cap | First Pass | 20 | | 15 |

    b. **Preferred Method -** Using a lead hammer, tap the end of the crankshaft to the rear.
    c. **Preferred Method -** Using a lead hammer, tap the end of the crankshaft to the front.
    d. **Preferred Method -** Do final pass torque on bearing cap.

| Description | | Nm | lb-in. | lb-ft |
|---|---|---|---|---|
| Crankshaft (Main) Bearing Cap Bolt and Stud - Preferred Method | | | | |
| Two Bolt Type Cap | Final Pass | + 73 degrees | | |

    e. **Optional Method -** Tap the end of the crankshaft to the rear and then to the front with a lead hammer.
    f. **Optional Method -** Evenly torque the rear main bearing cap to the specified amount.

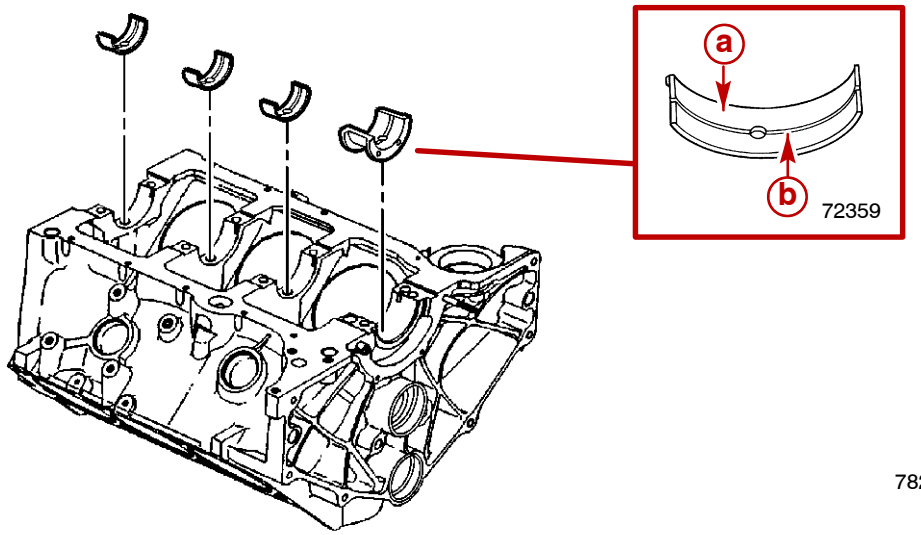
| Description | | Nm | lb-in. | lb-ft |
|---|---|---|---|---|
| Crankshaft (Main) Bearing Cap Bolt and Stud - Optional Method | | | | |
| Two Bolt Type Cap | One Pass - All Bolts Evenly Tightened | 105 | | 77 |

## MAIN BEARINGS AND CRANKSHAFT

1. Remove timing sprocket from old crankshaft and reinstall on new crankshaft.
2. **On driveshaft extension models -** if old pilot bushing is to be reused, bushing can be removed without damage as follows.
   a. Fill pilot bushing cavity with grease,
   b. Insert an old transmission input shaft in bore of bushing and hit it with a hammer. This will create hydraulic pressure in pilot bushing cavity that should force bushing out.

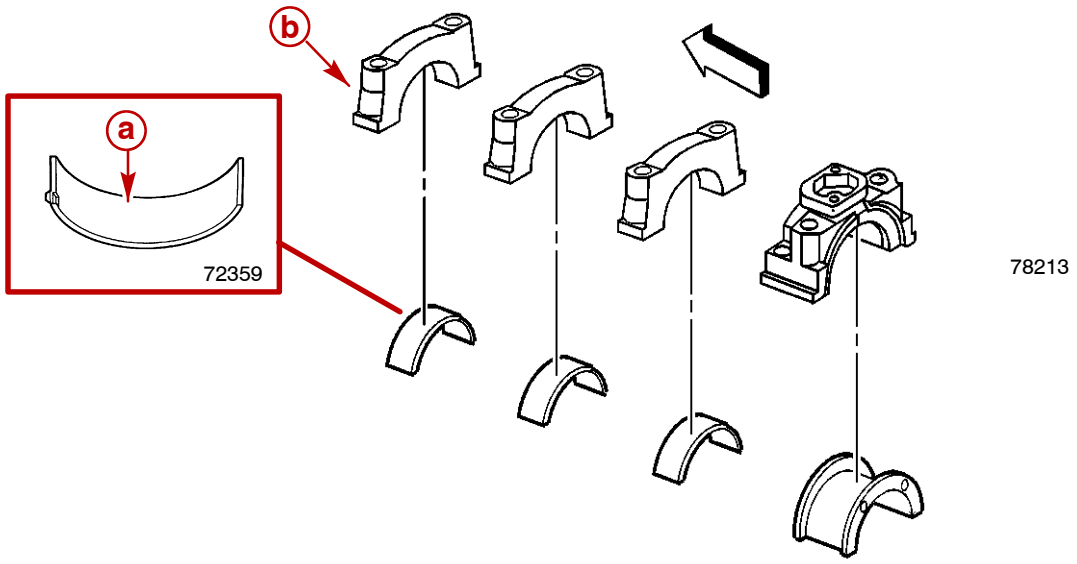
**IMPORTANT: Ensure that all bearings and crankshaft journals are clean.**

3. Install upper main bearing inserts in engine block.



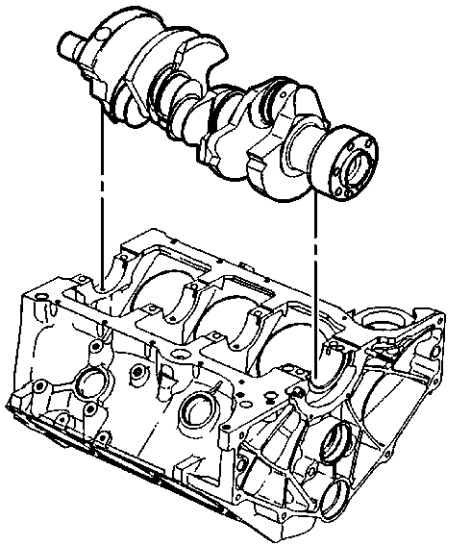

**a -** Upper Insert
**b -** Oil Groove

4. Install lower main bearing insert in main bearing caps.



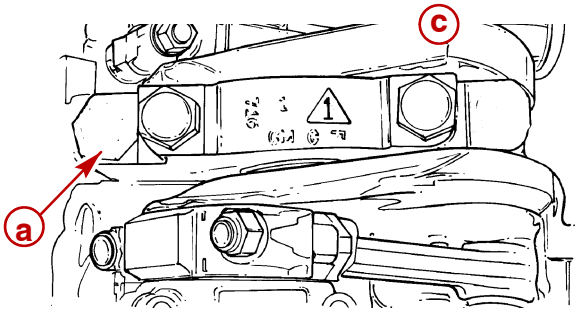

**a -** Lower Insert
**b -** Main Bearing Cap

5. Carefully lower crankshaft into place. Be careful not to damage bearing surfaces.



78211

6. Install main bearing caps in original location with markings pointing toward front of engine.

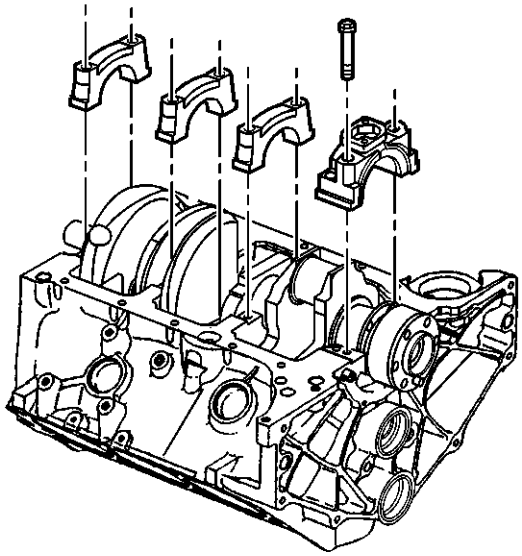



77467

7. Check clearance of each main bearing, following procedure outlined under Inspection - Main Bearing Clearance.
8. When bearing clearances meet specifications, lubricate the main bearings and crankshaft bearing journals.

| Description | Where Used | Part Number |
|---|---|---|
| Engine Oil | Main bearings and crankshaft bearing journals | Obtain Locally |

9. Install main bearing caps.



78210

10. Torque all main bearing caps, EXCEPT THE REAR MAIN CAP, to specifications.

| Description | | Nm | lb-in. | lb-ft |
|---|---|---|---|---|
| Crankshaft Main Bearing Cap Bolt and Stud - Preferred Method | | | | |
| Two Bolt Type Cap | First Pass | 20 | | 15 |
| | Final Pass | + 73 degrees | | |
| Crankshaft Main Bearing Cap Bolt and Stud - Optional Method | | | | |
| Two Bolt Type Cap | One Pass - All Bolts Evenly Tightened | 105 | | 77 |

11. Torque the rear main bearing cap.
    a. **Preferred Method -** Do first pass torque on rear main bearing cap.

| Description | | Nm | lb-in. | lb-ft |
|---|---|---|---|---|
| Crankshaft (Rear Main) Bearing Cap Bolt and Stud - Preferred Method | | | | |
| Two Bolt Type Cap | First Pass | 20 | | 15 |

    b. **Preferred Method -** Using a lead hammer, tap the end of the crankshaft to the rear.
    c. **Preferred Method -** Using a lead hammer, tap the end of the crankshaft to the front.
    d. **Preferred Method -** Do final pass torque on bearing cap.

| Description | | Nm | lb-in. | lb-ft |
|---|---|---|---|---|
| Crankshaft (Rear Main) Bearing Cap Bolt and Stud - Preferred Method | | | | |
| Two Bolt Type Cap | Final Pass | + 73 degrees | | |

    e. **Optional Method -** Tap the end of the crankshaft to the rear and then to the front with a lead hammer.
    f. **Optional Method -** Evenly torque the rear main bearing cap to the specified amount.

| Description | | Nm | lb-in. | lb-ft |
|---|---|---|---|---|
| Crankshaft (Rear Main) Bearing Cap Bolt and Stud - Optional Method | | | | |
| Two Bolt Type Cap | One Pass - All Bolts Evenly Tightened | 105 | | 77 |

12. Torque rear main bearing cap to specification.
13. Check crankshaft end play.
14. Install rear main seal retainer and seal.
15. Check clearance for each connecting rod bearing, following procedure under Connecting Rod, Bearings and Piston Assembly - Inspection.

16. If bearing clearances are satisfactory, coat the connecting rod bearing surface with lubricant.

| Description | Where Used | Part Number |
|---|---|---|
| Engine Oil | Connecting rod bearing surfaces | Obtain Locally |

17. Install the connecting rod cap.
18. In a two pass sequence, torque connecting rod cap nuts.

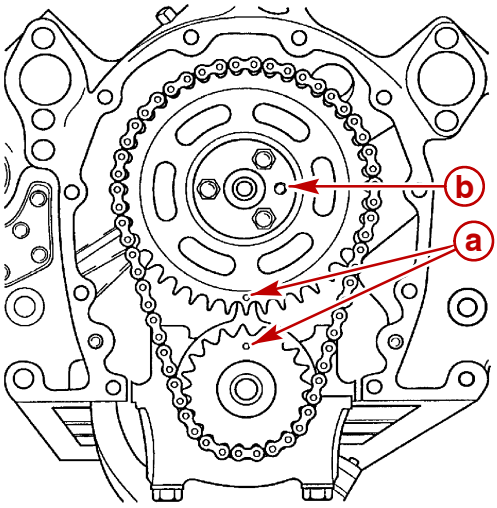
| Description | | Nm | lb-in. | lb-ft |
|---|---|---|---|---|
| Connecting Rod Nut - 4.3 liter (262 cid) | | | | |
| | First Pass | 27 | | 20 |
| | Final Pass (Angle Torque) | + 70 degrees | | |

19. Install timing chain.
20. Install front cover.
21. Install oil pump and crankshaft oil deflector.
22. Install dipstick tube and oil pan.
23. Install spark plugs.
24. Install crankshaft balancer and crankshaft pulley.
25. Install water circulating pump.
26. Install belt.
27. Install flywheel.
28. Install flywheel housing.
29. Install starter.
30. Install new oil filter.
31. Fill crankcase with oil. Refer to SECTION 1B.
32. Install engine in boat.

# Timing Chain And Sprockets

## Removal

1. Remove the serpentine belt.
2. Remove the water circulating pump.
3. Remove crankshaft balancer.
4. Remove oil pan.
5. Remove crankcase front cover.
6. Remove the crankshaft position sensor reluctor ring.
7. Turn crankshaft until timing marks on crankshaft and camshaft sprockets are in alignment or turn engine to cylinder number 1 TDC and mark both gears for alignment in reassembly.




72376

**Typical**

**a** - Alignment Marks
**b** - Locating Pin

8. Remove timing chain.
9. Remove camshaft sprocket.

***NOTE:*** *If sprocket does not come off easily, a light tap on the lower edge of the sprocket with a plastic mallet should dislodge it.*

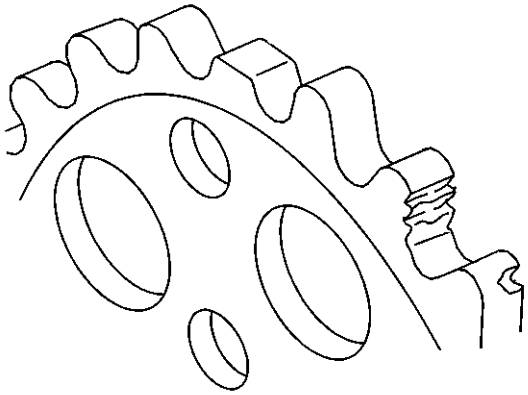
10. Remove crankshaft sprocket using crankshaft sprocket puller (J5825-A).

## Cleaning

1. Put on safety glasses.
2. Clean all parts in solvent.
3. Dry with compressed air.

## Inspection

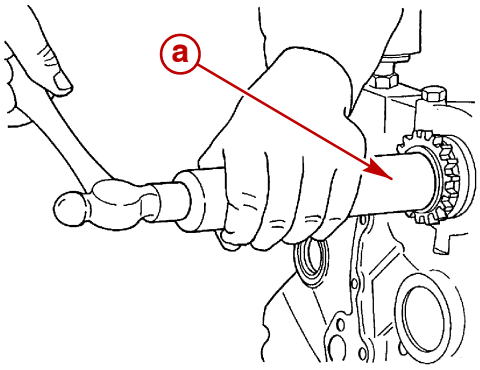
1. Inspect timing chain for wear and damage.
2. Inspect sprockets for wear and damage.



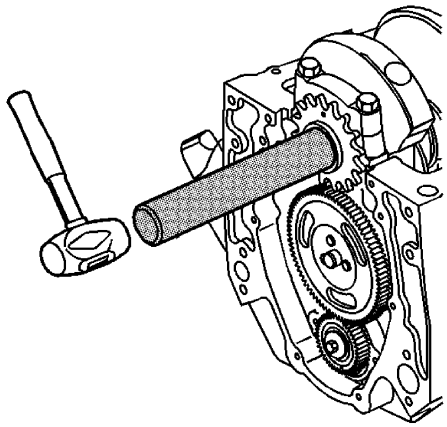
78204

## Reassembly

1. Install sprocket on crankshaft with crankshaft gear and sprocket installer.




72377

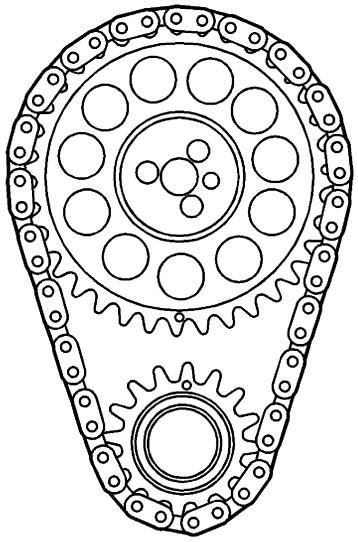


78238

**a** - Crankshaft Gear And Sprocket Installer (J5590)

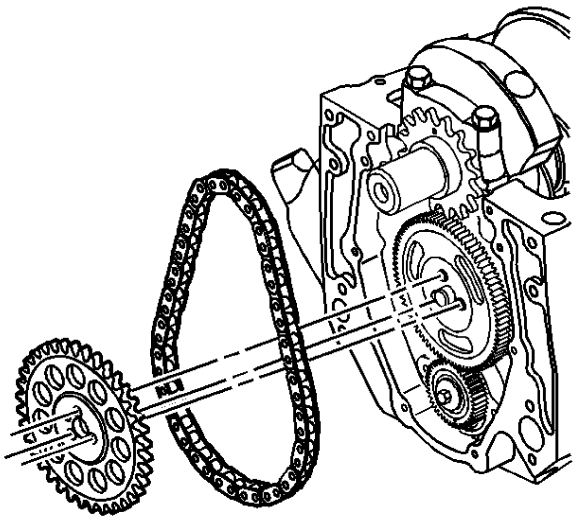
2. Align the marks on the crankshaft and the camshaft sprockets.

78239



3. Install camshaft sprocket and timing chain. Torque sprocket bolts.

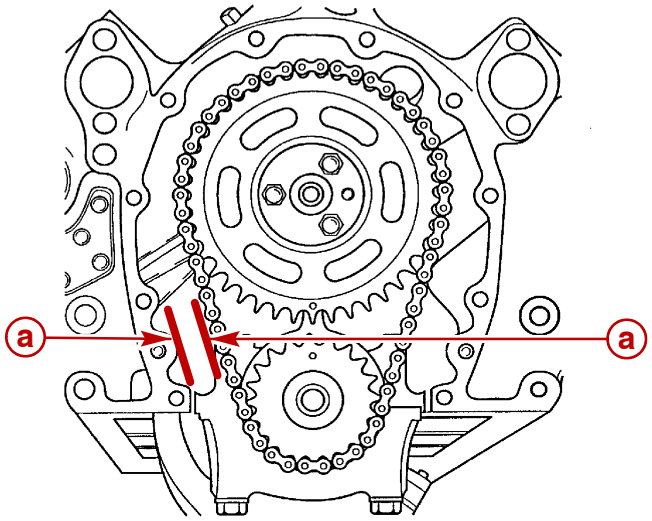
78228



| Description | Nm | lb-in. | lb-ft |
|---|---|---|---|
| Camshaft Sprocket Bolt | 25 | | 18 |

### CHECKING TIMING CHAIN DEFLECTION

1. Rotate camshaft (in either direction) to place tension on one side of the chain.
2. Establish a reference point on the block (on taut side of chain) and measure from this point to the chain.
3. Rotate camshaft in the opposite direction to slacken the chain, then force chain out with fingers and again measure the distance between reference point and timing chain.
4. The deflection is the difference between these two measurements. If the deflection exceeds specification, timing chain should be replaced.




72376

**a** - Reference Point

| Description | 4.3 liter (262 cid) |
|---|---|
| Chain Deflection | 11 mm (0.4331 in.) Maximum |

## Installation

1. Install the crankshaft position sensor reluctor ring.
2. Install front cover.
3. Install oil pan.
4. Install crankshaft balancer.
5. Install the water circulating pump.
6. Install the serpentine belt.

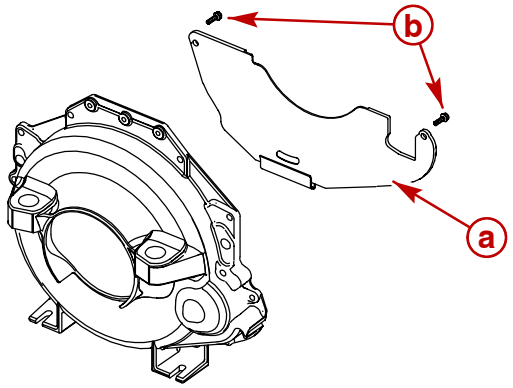
# Flywheel Housing

## Removal

1. Remove engine from boat.

**IMPORTANT: Use caution when removing water hoses; Do NOT bend ends of power steering cooler.**

2. Remove water hoses from power steering cooler.
3. Remove power steering cooler.
4. Remove flywheel housing cover.



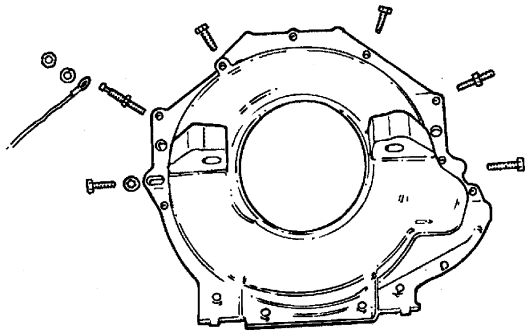

00000

**a** - Flywheel Housing Cover
**b** - Screws

5. Remove ground wires from flywheel housing.

**IMPORTANT: Flywheel housing bolts must be installed in same location as removed.**

6. Remove the bolts and studs from the flywheel housing.
7. Remove the flywheel housing.



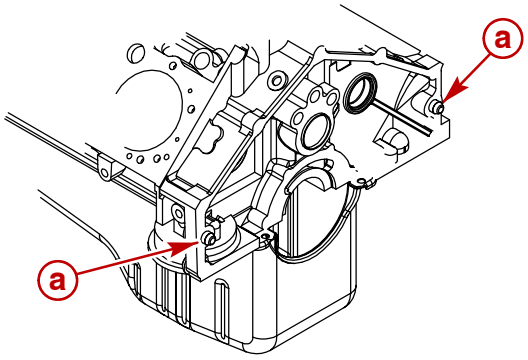
77444

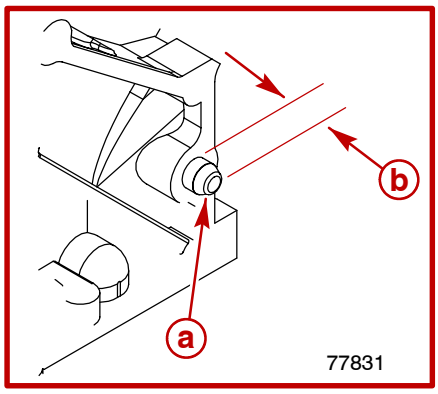
## Cleaning

1. Put on safety glasses.
2. Clean all parts in cleaning solvent.
3. Dry with compressed air.

## Inspection

1. Visually inspect flywheel housing for cracks, damaged bolt or stud holes and excessive wear. Replace if necessary.
2. Inspect guide dowels for proper position. Repair if necessary.




**a** - Guide Dowel
**b** - Measurement - 13 mm (0.5 in.)

## Installation

1. Align flywheel housing onto guide dowels on engine.

**IMPORTANT: Flywheel housing fasteners must be installed in same location as removed.**

2. Install studs and bolts in the original locations.
3. Torque flywheel housing studs and bolts.

| Description | Nm | lb-in. | lb-ft |
|---|---|---|---|
| Flywheel Housing Studs and Bolts | 41 | | 30 |

4. Install flywheel housing cover.

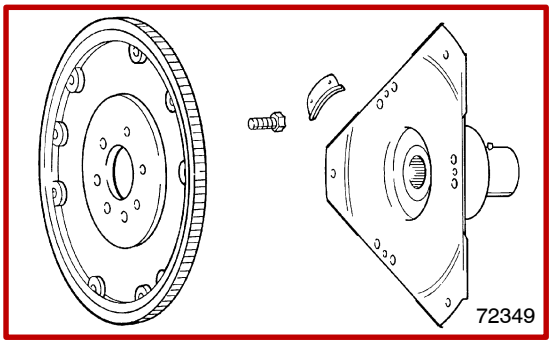
| Description | Nm | lb-in. | lb-ft |
|---|---|---|---|
| Flywheel Housing Cover | 9 | 80 | |

5. Install the ground wires.
6. Install power steering cooler.
7. Install water hoses.
8. Install the engine in the boat.

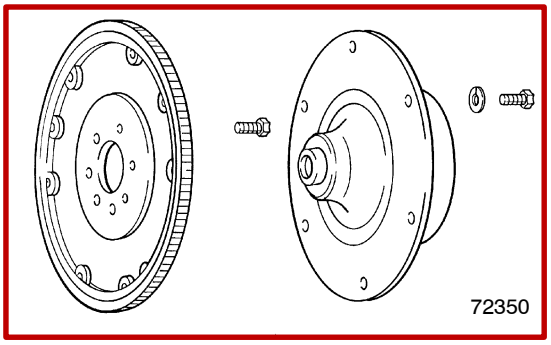
# Flywheel

## Removal

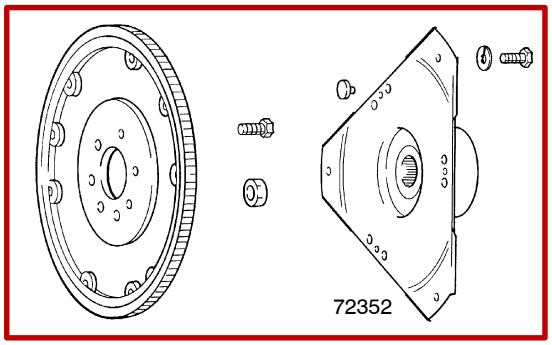
1. Remove engine from boat.
2. Remove flywheel housing.
3. Remove coupler or drive plate.




**Alpha Coupler**

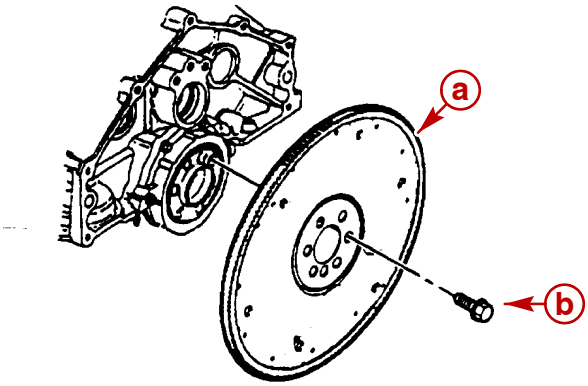



**Bravo Coupler**




**Drive Shaft Extension Coupler**

4. Remove the flywheel.



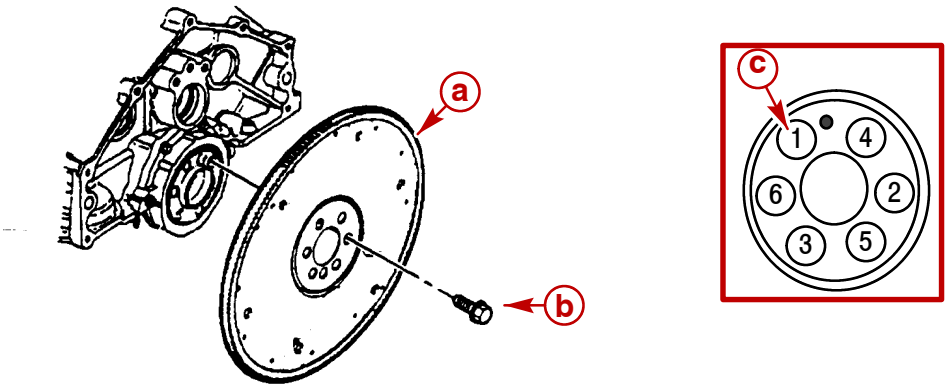

**a** - Flywheel
**b** - Bolts

## Cleaning and Inspection

1. Clean mating surfaces of flywheel and crankshaft. Remove any burrs. Mating surfaces must be clean, bare metal.
2. Check flywheel ring gear for worn and missing teeth.
3. Inspect splines in drive plate or coupler for wear.

## Installation

1. Align dowel hole in flywheel with dowel in crankshaft.
2. Install flywheel.
3. Install flywheel bolts. Torque bolts in sequence.

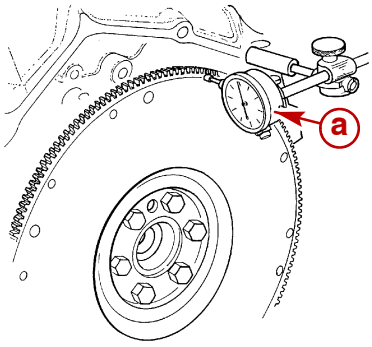



76490

**a** - Flywheel
**b** - Bolt
**c** - Numbered Sequence

| Description | Nm | lb-in. | lb-ft |
|---|---|---|---|
| Engine Flywheel Bolt | 100 | | 74 |

4. Check flywheel runout as follows:
   a. Attach a dial indicator to engine block. Take measurement around outer edge of flywheel.
   b. Push in on flywheel to remove crankshaft end play.
   c. Turn flywheel and measure runout.

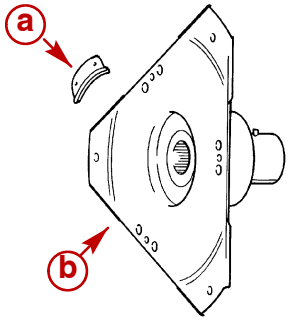



72353

**a** - Dial Indicator

| Description | 4.3 liter (262 cid) |
|---|---|
| Runout | 0.203 mm (0.0080 in.) Maximum |

5. Insert three rubber bumpers in Alpha coupler before installation on flywheel.




72354

**Typical**

**a** - Rubber Bumper (Alpha Coupler Only)
**b** - Coupler

6. Install drive coupler or drive plate. Torque bolts.

| Description | Nm | lb-in. | lb-ft |
|---|---|---|---|
| Coupler-to-Flywheel Bolts | 48 | | 35 |

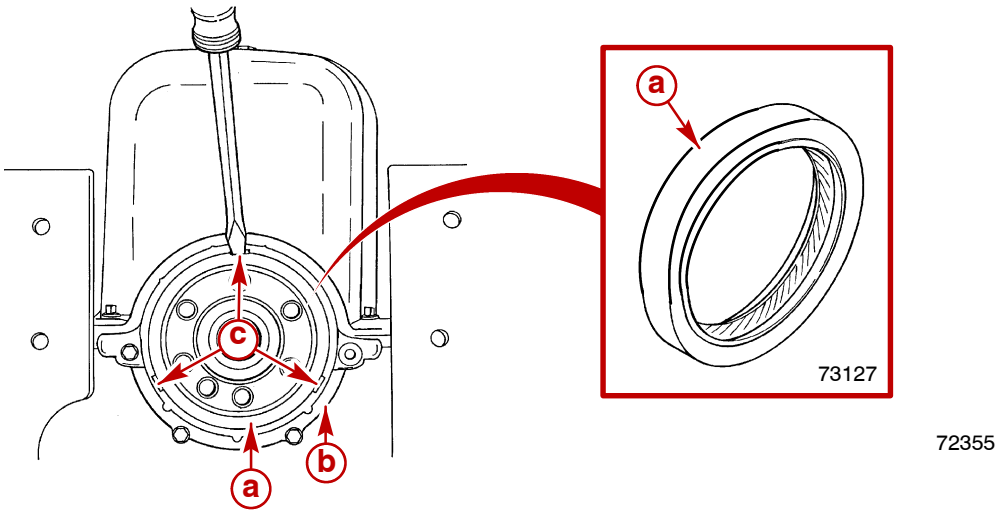
7. Install flywheel housing.
8. Install the engine in the boat.

# Rear Oil Seal

The rear crankshaft oil seal can be replaced without removing the oil pan or rear main bearing cap from engine.

## Removal

1. Remove the flywheel.
2. Remove rear oil seal by using a screwdriver to pry it out of the seal retainer.




**a** - Oil Seal
**b** - Seal Retainer
**c** - Slots (3)

## Cleaning

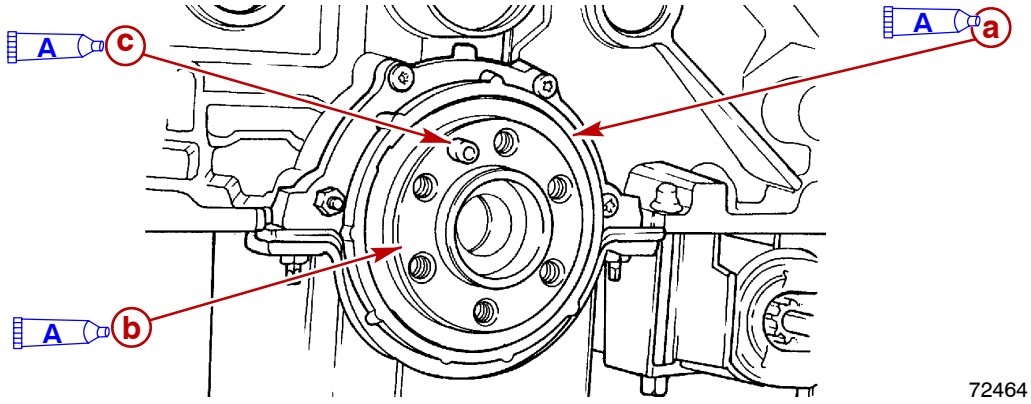
1. Clean crankshaft sealing surface.
2. Clean the rear oil seal retainer bore.

## Inspection

1. Inspect seal retainer bore for nicks and burrs. Minor imperfections may be removed with a fine grade emery cloth.
2. Inspect crankshaft sealing area for nicks, burrs and scoring.
3. Inspect the outside diameter of the engine flywheel pilot flange for imperfections or rust. Minor imperfections and/or rust may be removed with a fine grade emery cloth.

## Installation

1. Lightly lubricate the bore of the rear oil seal retainer.
2. Lightly lubricate the outside diameter of the flywheel pilot flange.
3. Lightly lubricate the outside diameter of the flywheel locator pin.
4. Lightly lubricate the outer diameter of the rear oil seal.



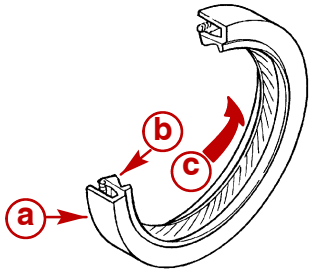

**a** - Retainer Bore
**b** - Flywheel Pilot Flange
**c** - Flywheel Locator Pin

| Description | | Where Used | Part Number |
|---|---|---|---|
| A | Engine Oil | Bore of rear oil seal retainer, Outside diameter of flywheel pilot flange, Outside diameter of flywheel locator pin, Outer diameter of rear oil seal | Obtain Locally |

5. Remove the installation guide from the new crankshaft rear oil seal.
6. Lightly lubricate the outside diameter of the new crankshaft rear oil seal.

| Description | Where Used | Part Number |
|---|---|---|
| Engine Oil | Outer diameter of rear oil seal | Obtain Locally |

7. Install the new crankshaft rear oil seal onto the rear oil seal installer J35621-B.

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**a** - Rear Oil Seal
**b** - Seal Lip Toward Inside of Engine
**c** - Rotation of Crankshaft as Viewed from Flywheel End Looking Forward

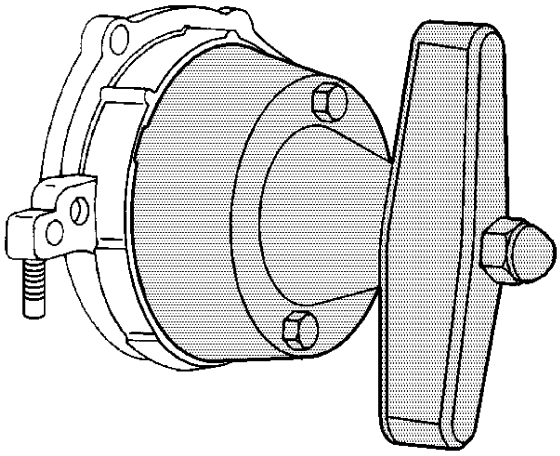
8. Install the rear oil seal installer onto the rear of the crankshaft and tighten the tool bolts until they contact.

**IMPORTANT: Do not allow oil or other lubricants to contact the seal surface of the rear oil seal.**

**⚠ CAUTION**

**Proper alignment of the crankshaft rear oil seal is critical. Install the rear oil seal near to flush and square to the rear oil seal retainer. Failing to do so may cause the rear oil seal or the Rear Oil Seal Installer tool to fail.**

9. Install the rear oil seal by turning the rear oil seal installer wing nut CLOCKWISE until the rear oil seal is almost flush with and evenly seated in the rear oil seal retainer.
10. Turn the rear oil seal installer wing nut COUNTERCLOCKWISE to release the rear oil seal installer from the rear oil seal.
11. Remove the rear oil seal installer from the crankshaft.



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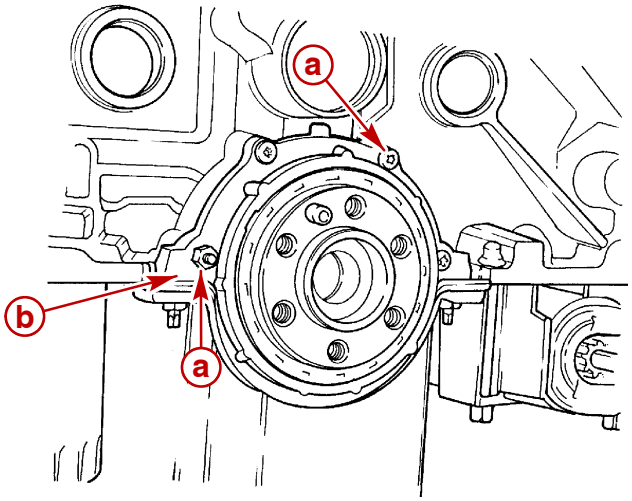
12. Wipe off any excess engine oil with a clean rag.

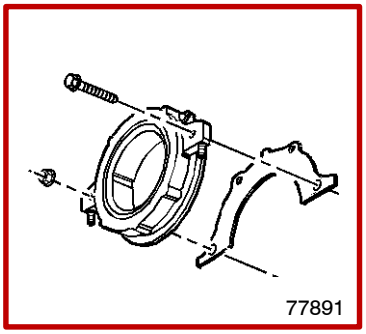
# Rear Oil Seal Retainer

The rear oil seal retainer can only be replaced with the oil pan removed.

## Removal

1. Remove oil pan.
2. Remove oil seal retainer fasteners.
3. Remove oil seal retainer.

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**a** - Fasteners
**b** - Oil Seal Retainer

4. Remove and discard the old gasket.

## Cleaning

1. Put on safety glasses.
2. Clean all sealing surfaces.
3. Wash all parts in solvent and dry with compressed air.

## Inspection

1. Inspect oil seal retainer for cracks or scored surface.
2. Inspect oil seal for worn, dry or torn rubber. Replace if necessary.
3. Inspect flywheel locator pin for damage. Replace if necessary.

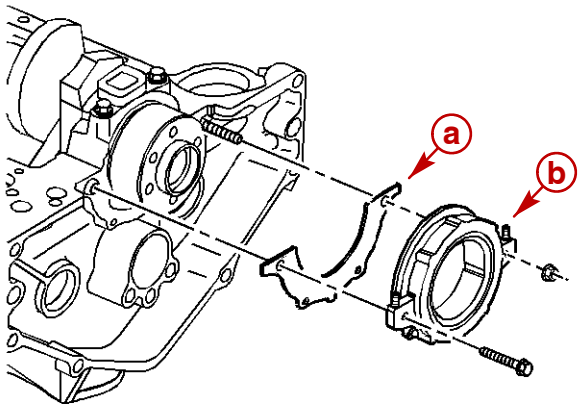
# Installation

**IMPORTANT: Always use a new oil seal retainer gasket when installing the crankshaft rear oil seal retainer.**

1. Install the rear oil seal retainer stud, if removed previously. Torque stud.

| Description | Nm | lb-in. | lb-ft |
|---|---|---|---|
| Rear Oil Seal Retainer Stud | 6 | 53 | |

2. Install new rear oil seal retainer gasket.
3. Install the rear oil seal retainer on the stud.

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**a** - Oil Seal Retainer Gasket
**b** - Rear Oil Seal Retainer

4. Install retainer nut and bolts. Torque nut and bolts.

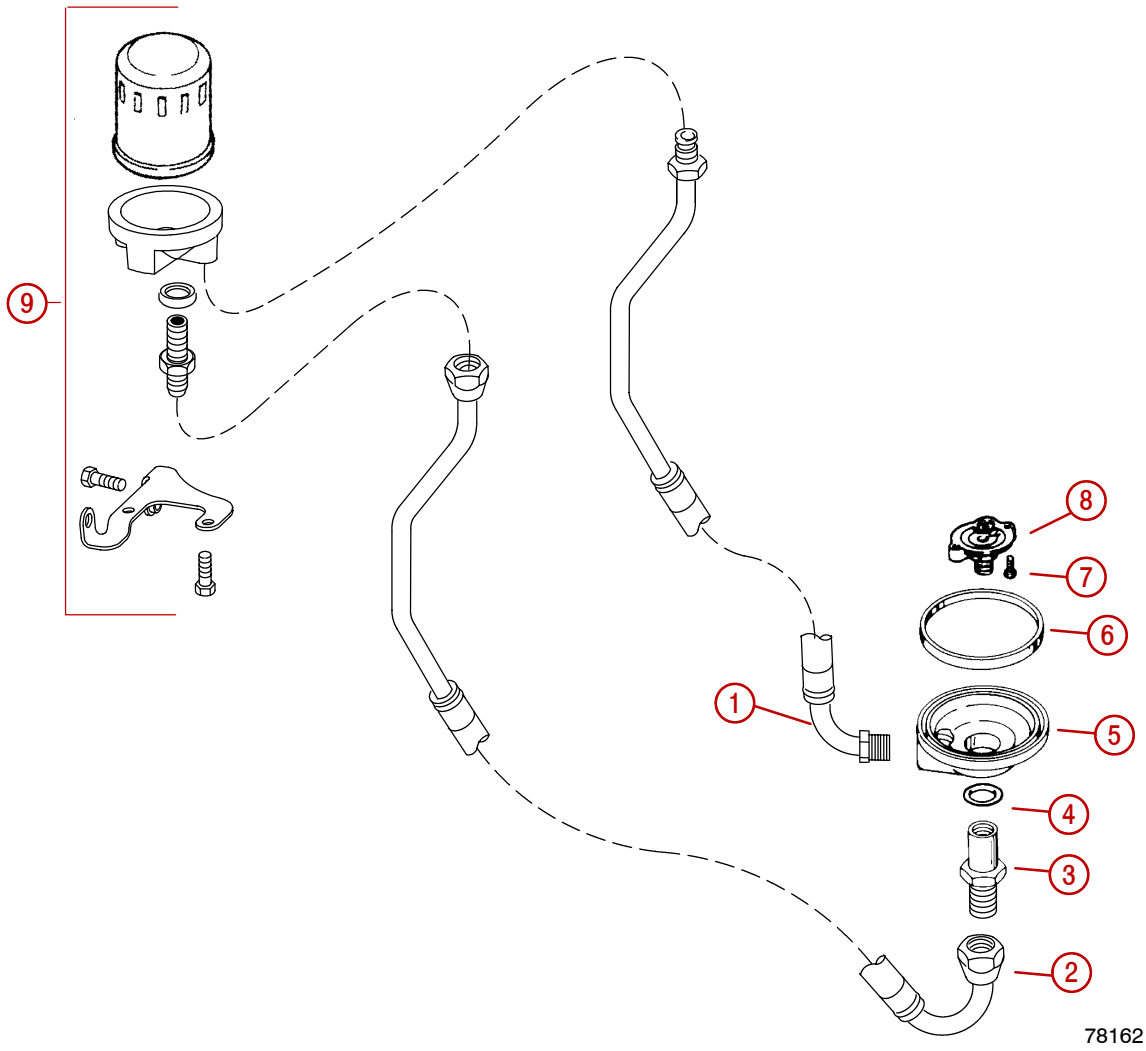
| Description | Nm | lb-in. | lb-ft |
|---|---|---|---|
| Rear Oil Seal Retainer Nut And Bolts | 12 | 106 | |

5. If not already installed, install the rear oil seal.
6. Install oil pan.

# Oil Filter By-Pass Valve and Block Adapter

**IMPORTANT: Oil filter by-pass valve and block adapter assembly should be inspected whenever engine is disassembled for major repair or whenever inadequate oil filtration is suspected.**

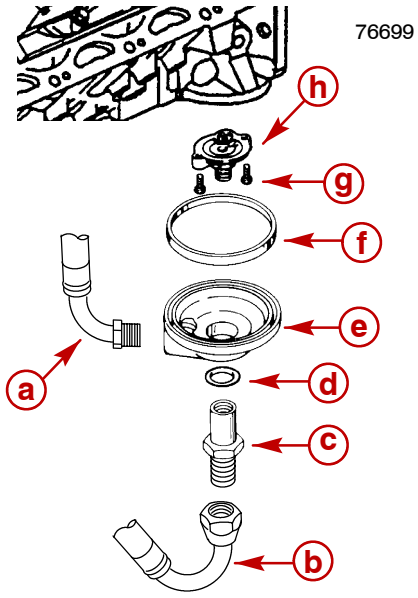
## Exploded View




**1** - Filter Adapter Oil Line
**2** - Fitting/Bushing Oil Line
**3** - Fitting/Bushing
**4** - Quad Ring Seal
**5** - Oil Filter Adapter
**6** - Seal
**7** - Bolt
**8** - Block Adapter And By-Pass Valve
**9** - Remote Oil Filter and Components

## Removal

1. Remove oil line from oil filter adapter.
2. Remove oil line from fitting/bushing.
3. Remove fitting/bushing and quad ring seal. Discard quad ring seal.
4. Remove oil filter adapter and seal. Discard seal.
5. Remove block adapter with by-pass valve.




**Typical**

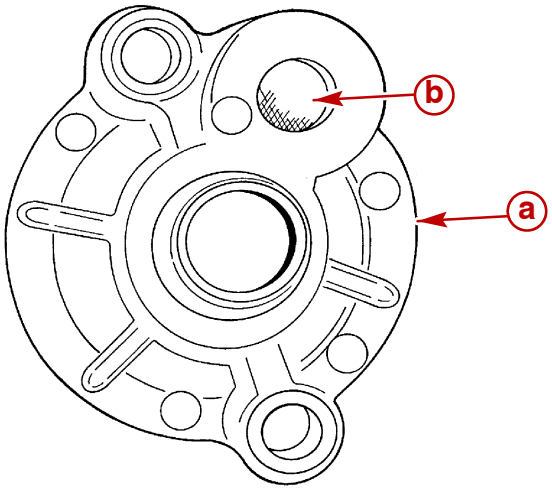
- **a** - Filter Adapter Oil Line
- **b** - Fitting/Bushing Oil Line
- **c** - Fitting/Bushing
- **d** - Quad Ring Seal
- **e** - Oil Filter Adapter
- **f** - Seal
- **g** - Bolt
- **h** - Block Adapter

## Cleaning

1. Put on safety glasses.
2. Clean by-pass valve and block adapter assembly in solvent.
3. Dry with compressed air.
4. Clean fitting/bushing and oil filter adapter in solvent.
5. Dry with compressed air.

## Inspection

1. Inspect the block adapter for cracks, thread wear or other damage.
2. Inspect by-pass (fiber) valve for cracks or other damage.
3. Ensure that by-pass valve fits tightly against its seat.
4. Push by-pass valve down and release it. Valve should return freely to its original position. If by-pass valve operation is questionable, replace the block adapter assembly.

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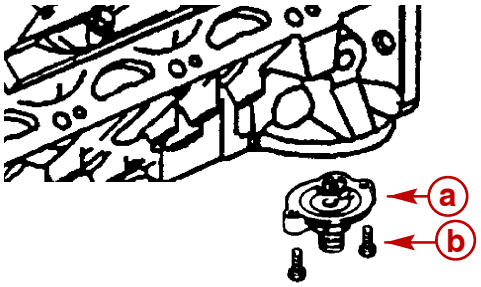
**Typical Block Adapter Assembly With By-Pass Valve**

**a** - Block Adapter Assembly
**b** - By-Pass (Fiber) Valve

5. Inspect the oil filter adapter and fitting/bushing for cracks, threads wear or other damage.

## Installation

1. Install block adapter with by-pass valve on engine block. Torque bolts.

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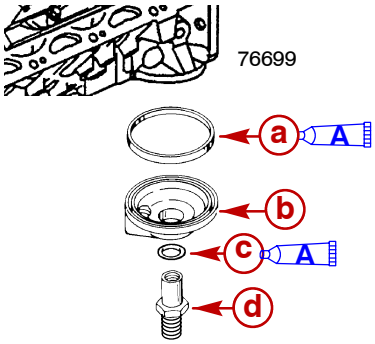
**a** - Block Adapter
**b** - Bolts

| Description | Nm | lb-in. | lb-ft |
|---|---|---|---|
| By-Pass Valve Block Adapter Bolt | 27 | | 20 |

2. Place a new seal in the oil filter adapter and lightly lubricate the sealing surfaces.
3. Install a new seal and oil filter adapter on engine block.
4. Lightly lubricate a new quad ring seal and place on the fitting/bushing.
5. Install fitting/bushing with quad ring seal. Torque fitting/bushing.

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**a** - Seal
**b** - Adapter
**c** - Quad Ring Seal
**d** - Fitting/Bushing

| Description | | Where Used | Part Number |
|---|---|---|---|
| A | Engine Oil | Oil filter adapter, quad ring for oil filter adaptor fitting/bushing | Obtain Locally |

| Description | Nm | lb-in. | lb-ft |
|---|---|---|---|
| Fitting/Bushing | 50 | | 37 |

6. Install oil lines on fitting/bushing and adapter.

| Description | Nm | lb-in. | lb-ft |
|---|---|---|---|
| Oil Lines | 27 | | 20 |

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# ELECTRICAL SYSTEM

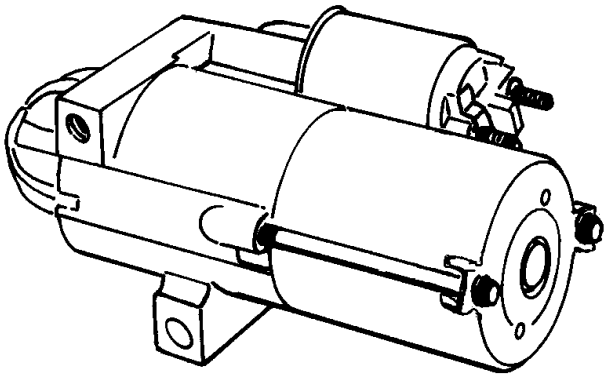
## Section 4A - Starting System

## Table of Contents


| | | | |
|---|---|---|---|
| Identification | 4A-2 | Lubricants / Sealants / Adhesives | 4A-5 |
| Replacement Parts Warning | 4A-2 | Description | 4A-5 |
| Precautions | 4A-2 | Testing | 4A-6 |
| Typical Starting System Components | 4A-3 | Removal | 4A-8 |
| Positive Current Flow | 4A-4 | Solenoid Switch | 4A-9 |
| Battery | 4A-4 | Inspection | 4A-9 |
| Battery Cable Recommendations | 4A-4 | Installation | 4A-10 |
| Delco PG260F1 Starter | 4A-5 | | |
| Specifications | 4A-5 | | |
| Starter Specifications | 4A-5 | | |
| Torque Specifications | 4A-5 | | |


4 A

# Identification



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**Delco PG260F1**

# Replacement Parts Warning

**⚠ WARNING**

**Electrical, ignition and fuel system components comply with U.S. Coast Guard Rules and Regulations to minimize risks of fire and explosion.**

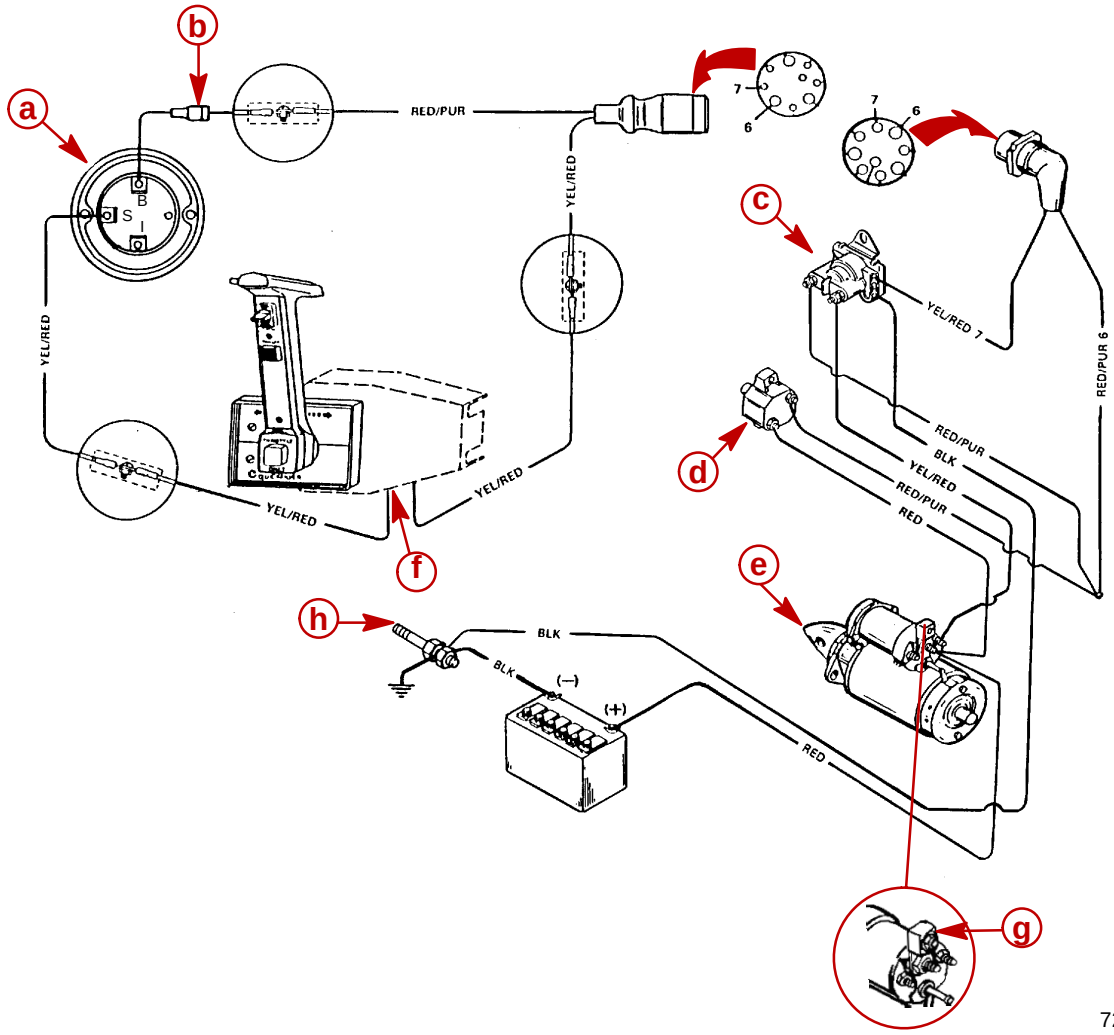
**Use of replacement electrical, ignition or fuel system components, which do not comply with these rules and regulations, could result in a fire or explosion hazard and should be avoided.**

# Precautions

**⚠ CAUTION**

**The starter motor is designed to operate under great overload and produce a high horsepower for its size. It can do this only for a short time, since considerable heat accumulates and can cause serious damage. For this reason, the cranking motor must never be used for more than 30 seconds at any one time. Cranking should not be repeated without a pause of at least 2 minutes to permit the heat to escape.**

# Typical Starting System Components

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**a** - Ignition Switch
**b** - 20 Amp Fuse
**c** - Starter Slave Solenoid
**d** - Circuit Breaker
**e** - Starter Motor
**f** - Neutral Safety Switch
**g** - 90 Amp. Fuse
**h** - Engine Ground (-)

# Positive Current Flow

This is a general description of the positive current flow from the battery through the system until the starter motor cranks.

***NOTE:*** *Ensure that all connections are tight and have the required resistance.*

- Battery to the solenoid switch (on starter) (RED battery cable).
- Solenoid switch to the circuit breaker (RED).
- Circuit breaker to the wire junction (RED/PUR).
- Wire junction to the wiring harness plug (RED/PUR) terminal 6.
- Wiring harness plug to the 20 amp fuse (RED/PUR).
- 20 amp fuse to the ignition switch terminal I (RED/PUR). At this point, the ignition switch is turned to START.
- Ignition switch terminal I to terminal C.
- Ignition switch terminal C to the neutral start switch (YEL/RED). NEUTRAL START SWITCH MUST BE AT NEUTRAL POSITION.
- Neutral start switch to the wiring harness plug terminal 7 (YEL/RED).
- Wiring harness plug to the starter solenoid (small terminal) (YEL/RED). Also, ensure that the black (small terminal) wire is grounded.
- Starter solenoid is now closed, completing the circuit between the large terminal (RED/PUR) and the other large terminal (YEL/RED), causing the starter motor to crank.

# Battery

## Battery Cable Recommendations

**IMPORTANT: The terminals must be soldered to the cable ends to ensure good electrical contact. Use electrical grade (resin flux) solder only. Do not use acid flux solder as it may cause corrosion and failure.**

| Cable Length | Cable Gauge | |
|---|---|---|
| 1.1 m (Up to 3-1/2 ft) | 25 $mm^2$ | (4) |
| 1.1 - 1.8 m (3-1/2 - 6 ft) | 35 $mm^2$ | (2) |
| 1.8 - 2.3 m (6 ft - 7-1/2 ft) | 50 $mm^2$ | (1) |
| 2.3 - 2.9 m (7-1/2 - 9-1/2 ft) | 50 $mm^2$ | (0) |
| 2.9 - 3.7 m (9-1/2 - 12 ft) | 70 $mm^2$ | (00) |
| 3.7 - 4.6 m (12 - 15 ft) | 95 $mm^2$ | (000) |
| 4.6 - 5.8 m (15 - 19 ft) | 120 $mm^2$ | (0000) |
| **Both positive (+) and negative (–) cables** | | |

# Delco PG260F1 Starter

# Specifications

## Starter Specifications

| PG260F1 Starter Motor | | | | | | |
|---|---|---|---|---|---|---|
| Mercury MerCruiser Part Number | | | 50-863007A1 | | | |
| Delco Identification Number | Engine Rotation | Volts | No Load Test | | | |
| | | | Minimum Amp | Maximum Amp | Minimum rpm | Maximum rpm |
| 9000884 | LH | 12.0 | 35 | 85 | 2550 | 4150 |

## Torque Specifications

| Description | Nm | lb-in. | lb-ft |
|---|---|---|---|
| Starter Mounting Bolts | 41 | | 30 |
| Battery Terminal | 9.5 | 84 | |
| Switch Terminal | 2.3 | 20 | |
| Resistor Terminal | 2.3 | 20 | |
| External Thru-bolt | 4.6 | 41 | |
| All Other Fasteners | Tighten Securely | | |

# Lubricants / Sealants / Adhesives

| Description | Where Used | Part Number |
|---|---|---|
| Liquid Neoprene | Terminals on the starter solenoid | 92-25711--3 |

# Description

The Permanent Magnet Gear Reduction starter motors feature small permanent magnets mounted inside the field frame (NOTE: The actual configuration of these magnets differs between the PG200, PG250 and PG260; the field frames with permanent magnets are not interchangeable. Otherwise, the units are similar.) These magnets take the place of current-carrying field coils mounted on iron pole pieces. Internal gear reduction, approximately 4:1 ratio, through planetary gears results in armature speeds in the 7000 rpm range. The armature and drive shaft are mounted on roller or ball bearings in place of bushings. The solenoid switch, plunger, return spring, and shift lever are permanently mounted in the drive housing.

# Testing

Other than water damage, low voltage causes most starter motor failures. Low voltage causes excessive heat to build up in the starter motor. It can also cause starter motor solenoid contact problems.

**IMPORTANT: Perform these tests with a digital voltmeter before removing the starter from the engine.**

1. Set the digital voltmeter to zero before testing.
2. Ensure that the battery is fully charged.
3. Remove the coil wire from the distributor cap and ground it to prevent the engine from starting.
4. Connect the voltmeter positive (+) lead directly to the large, threaded terminal.
5. Connect the voltmeter negative (–) lead directly to an unpainted metal surface on the starter housing.
6. Crank the engine over with the key switch for 10-15 seconds while watching the voltmeter.

- A voltmeter reading of 9.5 volts or more indicates that the battery is supplying sufficient voltage to the starter to operate properly. If the starter does not function properly, the starter or the engine are malfunctioning. Remove the spark plugs and try turning the engine over by hand to rule out an engine problem.
- A voltmeter reading below 9.5 volts indicates a voltage loss between the starter motor and the battery. Example: Voltage measured at the battery posts indicates 12.5 volts. Voltage measured at the starter indicates 9 volts. There is a 3.5 volt drop between the battery posts and the starter. Corroded battery cables, loose or dirty connections, loose battery cable terminal crimps, under size battery cable gauge for length used in boat, painted surfaces or battery switches could be the cause of this voltage drop.

**IMPORTANT: The maximum voltage drop allowed is 0.5 volts.**

## LOW VOLTAGE TEST

1. Test the battery positive (+) cable first. Connect voltmeter positive (+) lead directly to the battery positive (+) post, not the battery cable ring terminal. Connect voltmeter negative (–) lead directly to the large, threaded starter motor terminal that the battery positive (+) cable is connected to.

***NOTE:*** *Remove one voltmeter lead before starter motor is turned off or voltmeter damage may occur. The starter may produce a voltage spike that can damage a voltmeter.*

2. Crank the engine over while watching the voltmeter. The maximum allowed drop is 0.25 volts.

3. To find the point where the resistance is highest, leave the voltmeter positive (+) lead on the battery post and move the voltmeter negative (–) lead to the battery positive (+) cable ring terminal, that is on the threaded starter terminal.
4. Move voltmeter negative (–) lead to the battery cable itself that is inside the crimped battery cable ring terminal.
5. Test each battery cable connection in this manner all the way back to the battery positive (+) post. If a battery switch is used, check between the battery cable ring terminal and the switch's terminal.
6. Check for voltage drop on battery negative (–) cable. Connect voltmeter negative (–) lead directly to the battery negative (–) post, not the battery cable ring terminal. Connect voltmeter positive (+) lead to an unpainted surface of the starter housing.

***NOTE:*** *Remove one voltmeter lead before starter motor is turned off or voltmeter damage may occur. The starter may produce a voltage spike that can damage a voltmeter.*

7. Crank engine over while looking at the voltmeter.

**IMPORTANT: The maximum allowed drop is 0.25 volts.**

8. To find the point where the resistance is highest, leave voltmeter negative (–) lead on battery negative (–) post and move voltmeter positive (+) lead to the ground stud where the battery negative (–) cable is connected.
9. Move the voltmeter negative (+) lead to the battery negative (–) cable ring terminal that is on the ground stud.
10. Move voltmeter positive (+) lead to the battery cable itself that is inside the crimped battery cable ring terminal.
11. Test each battery cable connection in this manner back to the battery post.
12. After testing to ensure that the starter motor is getting at least 9.5 volts, test the starter motor solenoid to see if it is getting at least 9.5 volts from the slave solenoid during cranking. Low voltage at the starter solenoid can cause intermittent operation of the solenoid contacts and shorten the life of the solenoid.
13. Connect the voltmeter positive (+) lead to the terminal on the starter solenoid that has the YEL/RED wire from the slave solenoid connected to it.
14. Connect the voltmeter negative (–) lead to unpainted surface of the starter housing.
15. Crank engine over and watch the voltmeter. If the starter solenoid is not getting 9.5 volts, the YEL/RED wire or the slave solenoid could be the cause of the low voltage.

## WATER OR CORROSION INSPECTION

1. Remove the 2 short screws from the end cap and look at the threads.

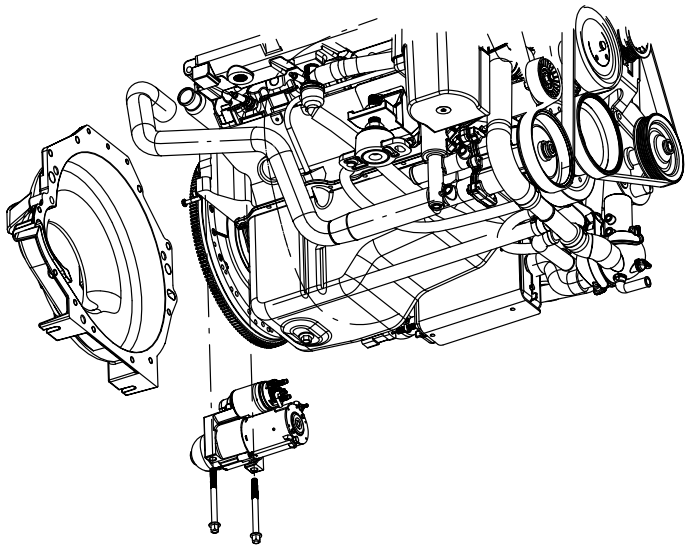
- If they are clean and gold in color, the starter motor did not have water inside of it.
- If they are dirty and black or gray in color, the starter motor may have had water on the inside of it and it should be replaced.

# Removal

**⚠ WARNING**

**Avoid injury or death and power package damage from an electrical shock, fire or explosion. Always disconnect both battery cables from the battery before servicing the power package.**

1. Disconnect the battery cables from the battery.
2. Disconnect the wires from the solenoid terminals.
3. Remove the starter mounting bolts.
4. Pull the starter assembly away from the flywheel and remove from the engine.



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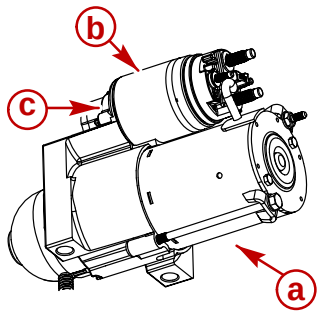
## Solenoid Switch

The solenoid switch can be removed and replaced if defective.

1. Remove the three fasteners retaining the solenoid. Remove the solenoid from the drive housing.



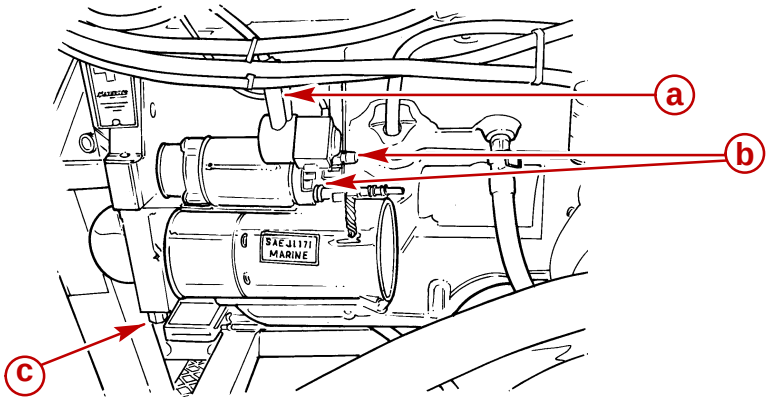

77945

**a** - Drive Housing
**b** - Solenoid
**c** - Fasteners (3)

# Inspection

The cranking motor and the solenoid are completely enclosed in the drive housing to prevent the entrance of moisture and dirt. However, periodic inspection is required as follows:

1. Inspect the terminals for corrosion and loose connections.
2. Inspect the wiring for frayed and worn insulation.
3. Ensure that the starter mounting bolts are tight.




77907

**a** - Wiring
**b** - Terminals
**c** - Mounting Bolts

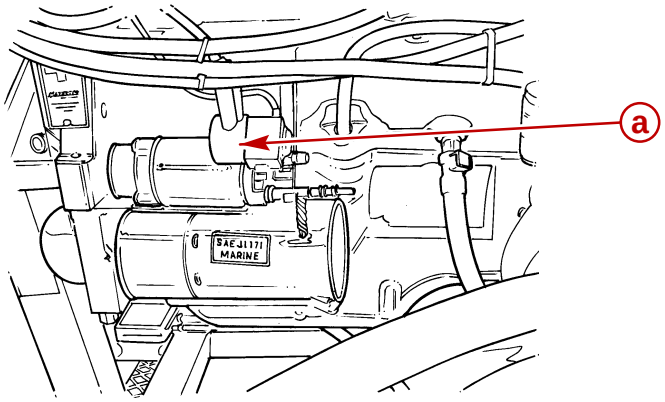
# Installation

**IMPORTANT: Install the special mounting shim (if equipped) between the starter motor and the engine block.**

1. Place the starter motor in position and install the mounting bolts. Torque the bolts.

| Description | Nm | lb-in. | lb-ft |
|---|---|---|---|
| Starter Motor Mounting Bolts | 41 | | 30 |

2. Connect the YELLOW/RED wire to the upper solenoid terminal. Connect the ORANGE wire, the RED wire, and the battery cable to the lower solenoid terminal. Coat the terminals with sealant. Install the battery cable boot, if equipped.




77907

**a -** Battery Cable Boot

| Description | Where Used | Part Number |
|---|---|---|
| Liquid Neoprene | Terminals on the starter solenoid | 92-25711--3 |

**PG 260 Series**

| Description | Nm | lb-in. | lb-ft |
|---|---|---|---|
| Battery Terminal | 9.5 | 84 | |
| Switch Terminal | 2.3 | 20 | |
| Resistor Terminal | 2.3 | 20 | |
| External Thru-bolt | 4.6 | 41 | |
| All Other Fasteners | Tighten Securely | | |

3. Connect the positive (+) battery cable to the positive (+) battery terminal and tighten the cable clamp.
4. Connect the negative (–) battery cable to the negative (–) battery terminal and tighten the clamp.

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# ELECTRICAL SYSTEM

## Section 4B - Ignition System

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4 B

# Specifications

## Spark Plugs

| Description | | Specification |
|---|---|---|
| Spark Plug | AC Platinum (AC 41-932) | 0.060 in. Gap |

## Distributor

| Description | Part Number |
|---|---|
| Distributor | Not Available at Time of Printing |

## Coil

| Description | Specification |
|---|---|
| Coil | Part Number 392-863704 |
| Primary Resistance | 0.60 - 0.80 Ohms |
| Secondary Resistance | 9,400-11,700 Ohms |

## Firing Order

| Description | Specification |
|---|---|
| Firing Order | 1-6-5-4-3-2 |

# Torque Specifications

| Description | | Nm | lb-in. | lb-ft |
|---|---|---|---|---|
| Spark Plugs | Initial Installation (NEW Cylinder Head) | 30 | | 22 |
| | All Subsequent Installations | 15 | | 11 |
| Distributor Hold Down Clamp | | 25 | | 18 |

# Lubricants / Sealants / Adhesives

| Description | Where Used | Part Number |
|---|---|---|
| Silicone Dielectric Compound | Coil High Tension Lead Tower | 92-823506-1 |

# Special Tools

| Description | Part Number |
|---|---|
| Multi-Meter / DVA Tester (DMM) | 91-99750A1 |

# Spark Plugs

## Removal

1. Disconnect the spark plug wires (high tension leads) from the spark plugs.

***NOTE:*** *Use care when removing the spark plug wires and boots from the spark plugs. Twist the boot 1/2 turn before removing. Firmly grasp and pull on the* ***boot*** *to remove the wire.*

2. Remove the spark plugs.

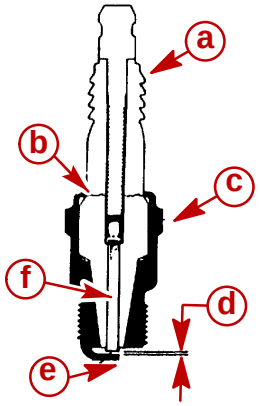
***NOTE:*** *A thin-walled spark plug socket may be required.*

## Inspection

1. Inspect each spark plug for the manufacturer and spark plug number. All plugs must be from the same manufacturer and have the same spark plug number.

| Description | | Specification |
|---|---|---|
| Spark Plug | AC Platinum (AC 41-932) | 0.060 in. Gap |

2. Inspect each plug individually for badly worn electrodes and for glazed, broken or blistered porcelain. Check the joint between the insulator and the shell for cracks. Replace where necessary.

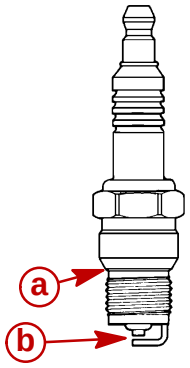



72734

**a** - Porcelain Insulator
**b** - Insulator
**c** - Shell
**d** - Proper Gap
**e** - Side Electrode
**f** - Center Electrode (When Adjusting Gap - DO NOT Bend)

## Replacing

1. Clean the spark plug seating area on the cylinder heads.
2. Adjust the spark plug gap with a round feeler gauge. Bend the side electrode to adjust the gap. Do NOT bend the center electrode.




75084

**a** - Seating Area
**b** - Gap

**IMPORTANT: Spark plugs should be torqued to the amount specified. In the absence of a torque wrench or access problems to the plugs, the spark plugs should be hand tightened until the plug seats on the cylinder head and then securely tightened with the appropriate ratchet and socket.**

3. Install the spark plugs and torque.

| Description | | Nm | lb-in. | lb-ft |
|---|---|---|---|---|
| Spark Plugs | Initial Installation (NEW Cylinder Head) | 30 | | 22 |
| | All Subsequent Installations | 15 | | 11 |

4. Install the spark plug wires in the proper order.

# Spark Plug Wires

## Inspection

1. Visually inspect the spark plug wires and the coil wire for damage.
2. Visually inspect the spark plug boots for damage.

***NOTE:*** *Use care when removing the spark plug wires and the boots from the spark plugs. Twist the boot 1/2 turn before removing. Firmly grasp and pull on the* ***boot*** *to remove the wire end.*

3. Check the spark plug wires and the coil wire for continuity using a DMM. Replace any wires that do not show continuity from end to end.
4. Replace any damaged wires.

## Replacing

**IMPORTANT: Use only the spark plug wires recommended for marine applications.**

***NOTE:*** *When replacing the spark plug wires, replace one wire at a time to reduce the risk of error.*

1. Disconnect the individual spark plug wires.
2. Install the spark plug wires in the proper order. Observe the following:

**IMPORTANT: When replacing the plug wires, route the wires correctly through the proper supports. Correct positioning of the spark plug wires and supports is important to prevent cross-firing.**

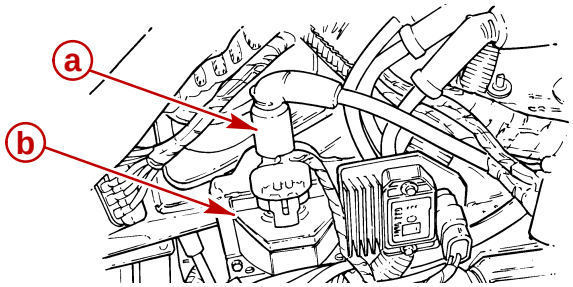
   a. Position the wires in the spark plug wire supports and retainers.
   b. Attach the plug wires to the appropriate spark plug and terminal on the distributor cap. Each end should fit securely.

**IMPORTANT: Before installing the coil wire (high tension lead) to the coil, apply approximately 1/2 oz. of silicone dielectric compound around the top of the coil high tension lead tower. Do not apply to the inside of the tower hole.**

c. Seal the coil high tension lead tower. Attach the coil wire to the center terminal on the distributor cap and to the coil.

| Description | Where Used | Part Number |
|---|---|---|
| Silicone Dielectric Compound | Coil high tension lead tower | 92-823506-1 |

d. Push the end of the high tension wire into the coil tower. Position the boot over the coil tower and wipe off excess insulating compound.




78271

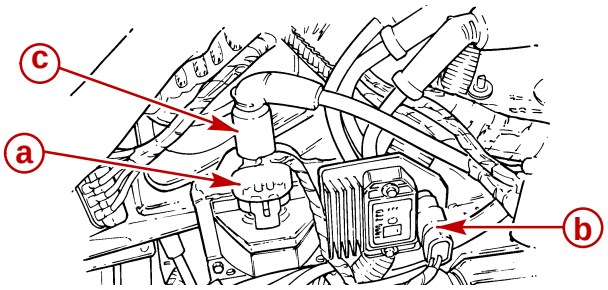
**a** - Coil Wire
**b** - Coil

***NOTE:*** *Ensure that the boot does not come off of the tower due to hydraulic air pressure inside the boot.*

# Ignition Coil

## Removal

1. Disconnect the wire harness connector at the coil.
2. Disconnect the ignition module wire harness connector.
3. Remove the high tension coil lead.



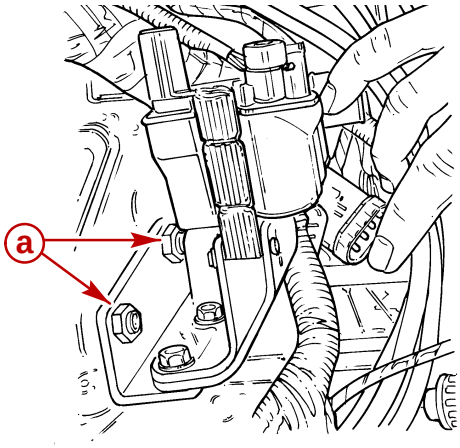

78271

**a** - Coil Wire Harness Connection
**b** - Ignition Module Wire Connection
**c** - High Tension Coil Lead Connection

4. Remove the coil bracket fasteners and remove the coil bracket assembly from the engine.
5. Remove the coil from the coil bracket.

## Installation

1. Install the coil bracket with the coil to the engine bracket using the fasteners.

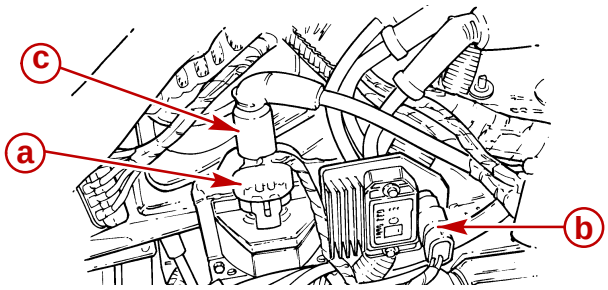



77922

**a -** Coil Bracket Fasteners

**IMPORTANT: Before installing the coil wire (high tension lead) to the coil, apply approximately 1/2 oz. of Silicone Dielectric Compound around the top of the coil high tension lead tower. Do not apply to the inside of the tower hole.**

2. Connect the high tension coil lead.




78271

**a -** Coil Wire Harness Connection
**b -** Ignition Module Wire Connection
**c -** High Tension Coil Lead Connection

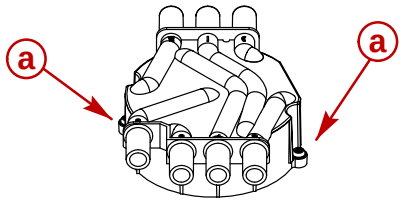
| Description | Where Used | Part Number |
|---|---|---|
| Silicone Dielectric Compound | Coil high tension lead tower | 92-823506-1 |

3. Connect the wire harness connectors.

# Distributor

## Removal

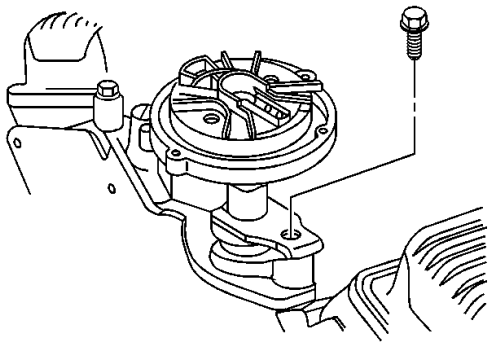
1. Remove all spark plug wires.
2. Remove the two screws fastening the distributor cap to the distributor.
3. Remove the distributor cap and set it aside.




78115

**a -** Screws

4. Scribe a line on the distributor housing marking the position of the rotor. Also, mark the position of the distributor housing on the intake manifold.
5. Remove the bolt retaining the distributor.

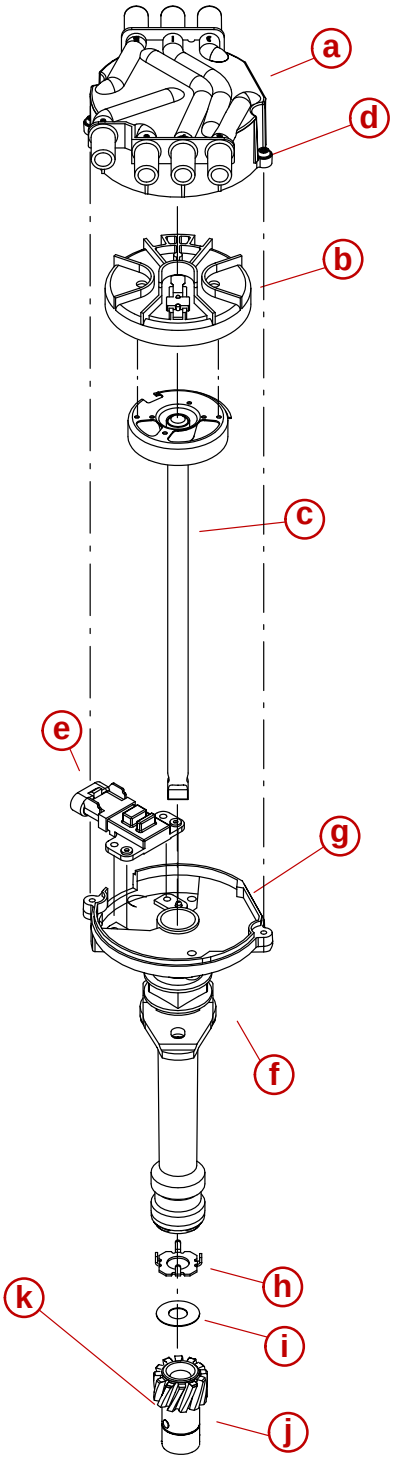


77850

6. Remove the distributor and the gasket from the intake manifold.

**IMPORTANT: Do NOT crank the engine over after the distributor has been removed unless engine is being disassembled. If the engine is disassembled, you will need to ensure that the engine is at number 1 cylinder TDC before installing the distributor.**

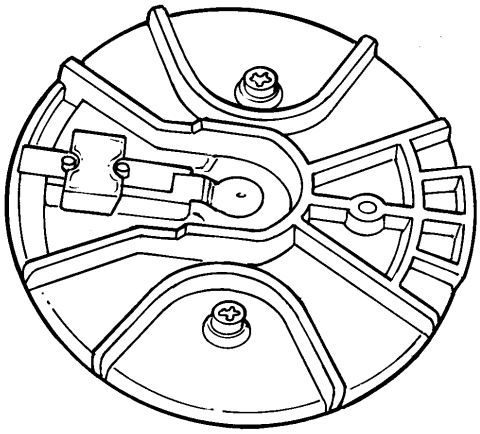
# Disassembly




78115

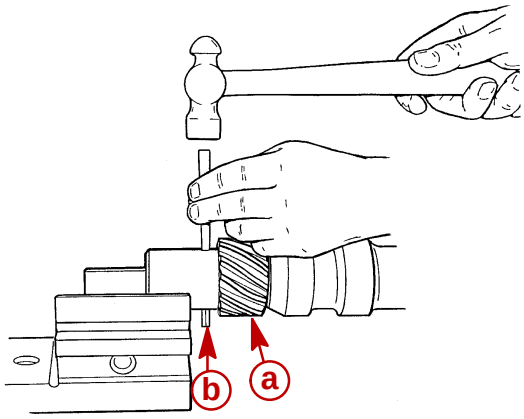
**a** - Cap
**b** - Rotor
**c** - Shaft Assembly
**d** - Screw
**e** - Module (Not Used)
**f** - Housing
**g** - Gasket
**h** - Tang Washer
**i** - Washer
**j** - Gear
**k** - Pin

1. Remove the rotor from the shaft by removing 2 torx fasteners.



77918

2. Remove the roll pin.




72917

**a** - Gear
**b** - Roll Pin

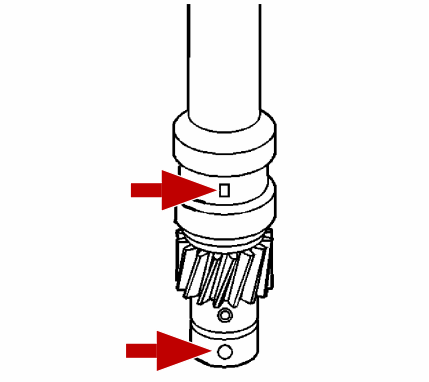
3. Remove the gear, the washer and the tang washer.
4. Remove the shaft assembly from the housing.

## Cleaning and Inspection

1. Visually inspect the cap for cracks or carbon tracks. Replace the cap if it shows any sign of damage.
2. Check the metal terminals in the cap for evidence of corrosion. Use a knife to scrape surfaces clean. If the corrosion is deep, replace the cap.
3. Inspect for signs of wear or burning at the outer terminal of the rotor. The presence of carbon on the terminal indicates serious rotor wear and the need for replacement.
4. Inspect the shaft for shaft-to-bushing looseness. Insert the shaft in the housing. If the shaft wobbles, indicating a loose fit, replace the housing and/or shaft.
5. Clean the metal parts in solvent and dry with compressed air.
6. Check the housing for signs of cracks or damage; replace if necessary.

## Reassembly

1. Lubricate the shaft with grease and install into the housing.
2. Install the tang washer, the washer and the drive gear onto the shaft.
3. Temporarily install the rotor on the shaft. Align the scribe marks on the gear, the housing, and the rotor.
4. Install the roll pin through the gear and the shaft.
5. Spin the shaft to ensure that it spins freely.
6. Align the distributor shaft keyways.



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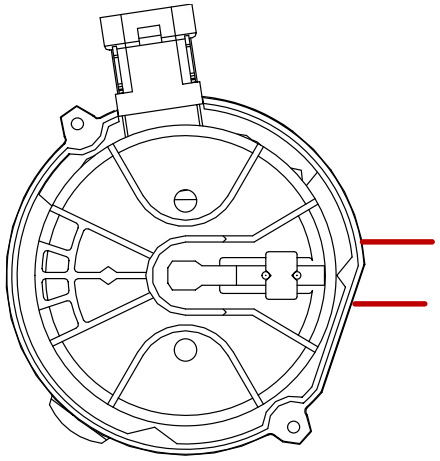
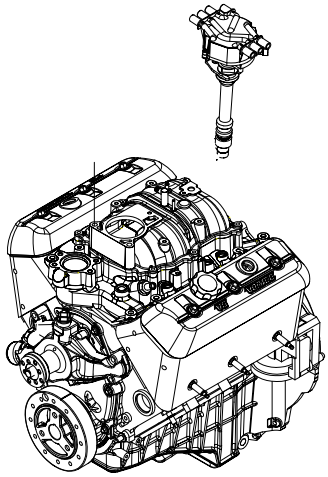
7. Install the rotor onto the shaft. If the engine is at number 1 cylinder TDC, the tang must be aligned between the two marks.



78144

## Installation

1. If the engine was completely disassembled, verify that the engine is at number 1 cylinder TDC. Verify that the rotor tang is in the proper location as shown above.
2. If only the distributor was removed, align the rotor, the housing and the intake manifold using the scribe marks.
3. Slowly lower the distributor (with gasket) through the intake manifold and into position. If the distributor shaft will not drop into position, turn until it drops into position.

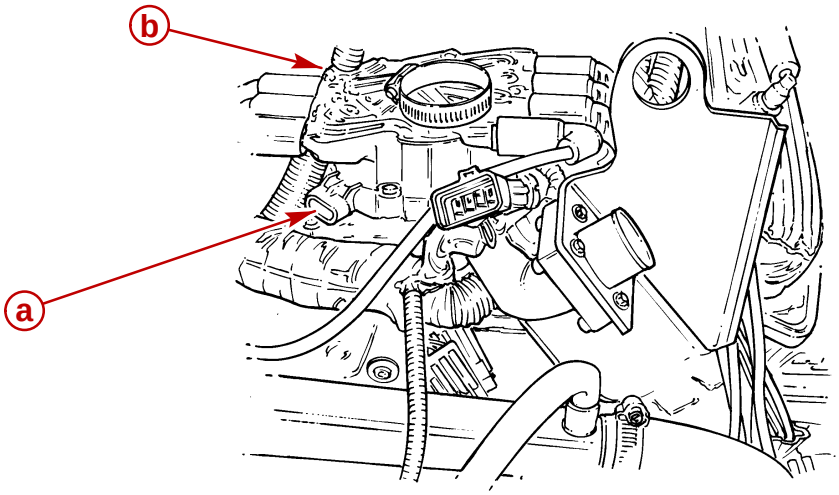


78268

4. Install the hold-down clamp over the distributor and bolt it securely to the engine surface. Torque the bolt.

| Description | Nm | lb-in. | lb-ft |
|---|---|---|---|
| Distributor Hold Down Clamp | 40 | | 30 |

5. Install the distributor cap and secure in place with two torx fasteners.
6. Connect the spark plug wires.

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**a** - Plug Not Used
**b** - Spark Plug Wires

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# ELECTRICAL SYSTEM

## Section 4C - Charging System

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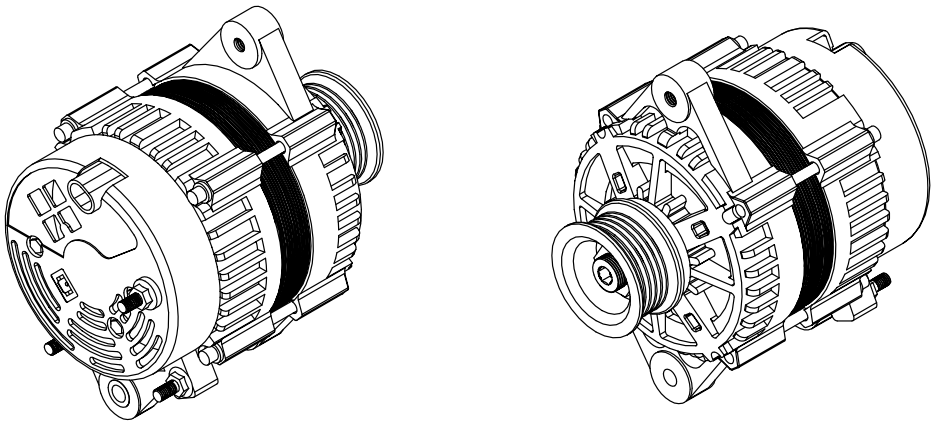
4 C

# Delco Alternator

## Identification



78134

## Replacement Parts Warning

**⚠ WARNING**

**The electrical, the ignition and the fuel system components on your Mercury MerCruiser are designed and manufactured to comply with U.S. Coast Guard Rules and Regulations to minimize the risks of fire and explosion.**

**Use of replacement electrical, ignition or fuel system components, which do not comply with these rules and regulations, could result in a fire or an explosion hazard and should be avoided.**

## Specifications

| Description | Specification |
|---|---|
| Excitation Circuit | 1.3 to 2.5 volts |
| Current Output | 60 Amp Minimum |
| Voltage Output | 13.9 to 14.7 volts |
| Minimum Brush Length | 6 mm (1/4 in.) |

## Torque Specifications

| Description | | Nm | lb-in. | lb-ft |
|---|---|---|---|---|
| Alternator to Mounting Bracket | | 48 | | 35 |
| Alternator Mounting Bracket | | 41 | | 30 |
| Belt Tension | | See Note | | |
| Battery Nut Terminal | | 7 | | 62 |
| Mounting Bolts | M8 x 1.25 | 11 | | 8 |

***NOTE:*** *Belt deflection is to be measured on the belt at the location that has the longest distance between 2 pulleys. Refer to SECTION 1B.*

## Special Tools

| Description | Part Number |
|---|---|
| Multi-Meter / DVA Tester (DMM) | 91-99750A1 |
| Ammeter (0-100 Amp) | Obtain Locally |

# Precautions

The following precautions MUST BE observed when working on the charging system. Failure to observe these precautions may result in serious damage to the alternator or charging system.

1. Do NOT attempt to polarize the alternator.
2. Do NOT short across or ground any of the terminals on the alternator, except as specifically instructed in the Troubleshooting Tests.
3. NEVER disconnect the alternator output lead or battery cables when the alternator is operating.
4. NEVER disconnect the regulator lead from the alternator regulator terminal when the alternator is operating.
5. ALWAYS remove the negative (–) battery cable from the battery before working on the charging system.
6. When installing the battery, BE SURE to connect the positive (+) battery cable to the positive (+) battery terminal and the negative (–) (grounded) battery cable to the negative (–) battery terminal.
7. If a charger or booster battery is to be used, BE SURE to connect it in parallel with the existing battery (positive to positive; negative to negative).

## EFI Electrical System Precautions

**⚠ CAUTION**

**Avoid damage to the EFI electrical system and components. Refer to the following precautions when working on or around the EFI electrical harness or when adding other electrical accessories:**

- **DO NOT tap accessories into the engine harness.**
- **DO NOT puncture wires for testing (Probing).**
- **DO NOT reverse the battery leads.**
- **DO NOT splice wires into the harness.**
- **DO NOT attempt diagnostics without proper, approved Service Tools.**

# Charging System Components

The charging system consists of the alternator, the battery, the ignition switch and the wiring that connects these components.

# Periodic Maintenance

**⚠ WARNING**

**Avoid injury or death and power package damage from an electrical shock, fire or explosion. Always disconnect both battery cables from the battery before servicing the power package.**

1. Inspect the entire alternator system for corroded or loose connectors.
2. Check the wiring for frayed or worn insulation.
3. Check the alternator drive belt for excessive wear, cracks, fraying and glazed surfaces. Also, check the drive belt tension and adjust; refer to SECTION 1B.
4. Check the alternator mounting bolts for adequate tightness.
5. Inspect the flame arrestor screen for debris and clean using compressed air or a cloth. The screen MUST BE clean or the alternator may overheat.

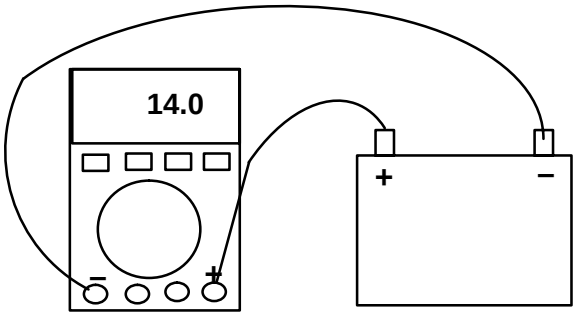
# Troubleshooting Tests (Alternator on Engine)

Use the following tests in conjunction with SECTION 1C - Troubleshooting. Before proceeding with the tests, perform the following checks to eliminate possible problem areas. Observe the Precautions to prevent damage to the alternator system.

1. An undercharged battery can be caused by excessive current draw, from accessories or by operating the engine at low speeds for extended periods.
2. Check the physical condition and the battery charge. The battery MUST BE at least 75 percent (1.230 specific gravity) of fully charged to obtain valid results in the following tests. If not, charge the battery before testing the system.
3. Inspect the entire charging system wiring for defects. Ensure that all connections are secure and clean.
4. Check the alternator drive belt for excessive wear, cracks, fraying and glazed surfaces. Replace if necessary. Also, check the drive belt tension and adjust if necessary.

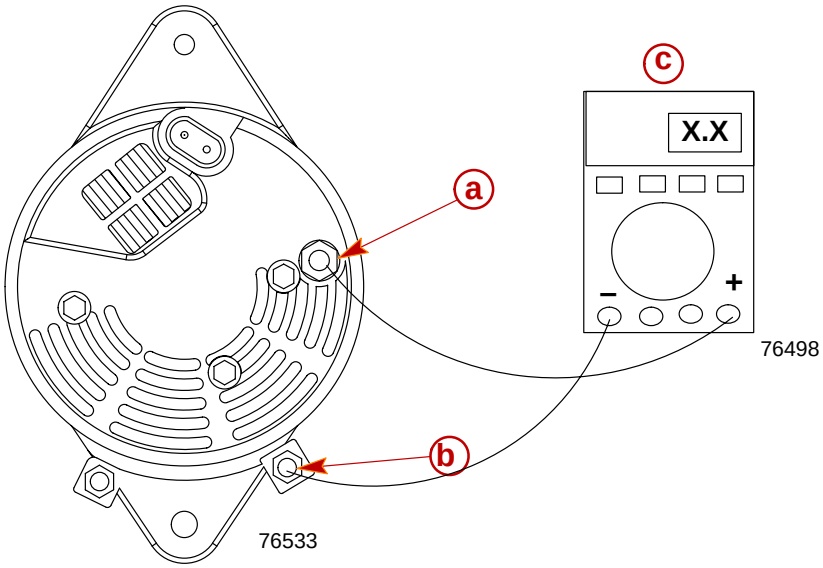
# Charging System

1. Check the belt condition and tension.
2. Check the battery condition.
3. With a fully charged battery, connect the voltmeter leads directly to the battery posts.




76498

4. Supply cooling water to the engine.
5. Start the engine and operate at 1300-1500 rpm. Read the voltmeter in VDC position. Most systems will read 13.8-14.8 volts.
6. If the reading is between 13.5 and 14.8 volts, switch the DVOM to the AC volt position. and observe. A reading of 0.25 AC volts or less indicates that the alternator diodes are fully functional. A reading above 0.25 AC volts indicates that the diodes are faulty and the alternator must be replaced.
7. If the reading is below 13.5 volts:
   a. Connect the positive (+) voltmeter lead to the alternator output post.
   b. Connect the negative (–) lead to the ground post on the alternator.




76498

76533

**Typical**

**a** - Output Terminal
**b** - Ground Terminal
**c** - Voltmeter

c. Wiggle the engine wiring harness while observing the voltmeter. The meter should indicate the approximate battery voltage and should not vary. If no reading is obtained, or if the reading varies, refer to Resistance in this section.

d. If the reading is above 15 volts:, the alternator is overcharging and must be replaced.

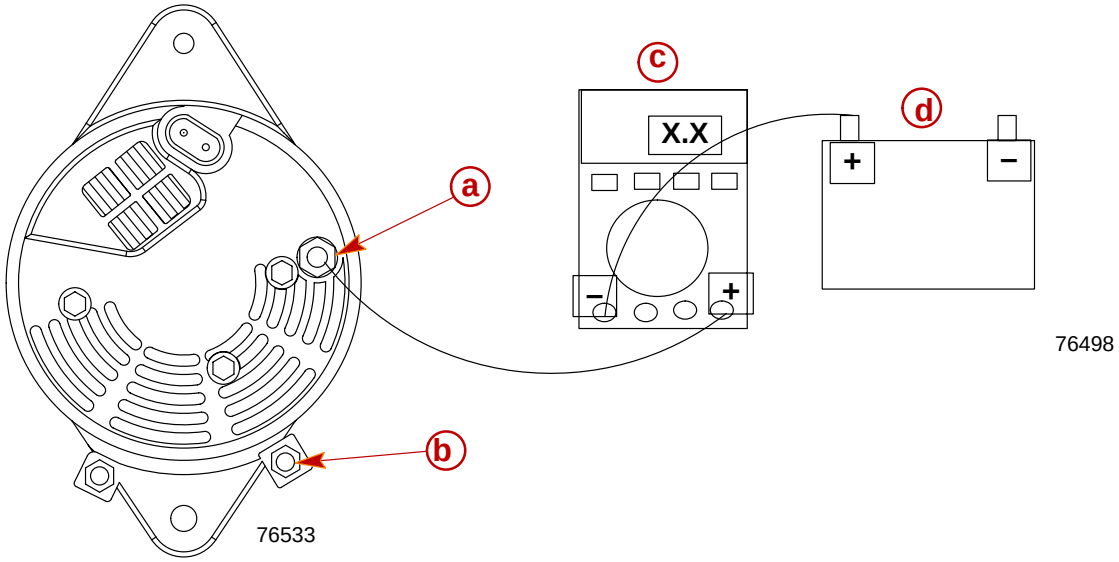
e. If the voltmeter reading is now within specifications, there is too much resistance between the alternator and the battery.

f. If the reading is below 12.5 volts, the alternator may not be charging. Check all wiring leading to the alternator.

## Resistance

1. Disconnect the coil wire so that the engine does not start.
2. Crank the engine over for 15 seconds to discharge the battery slightly.
3. Reconnect both the coil wire and turn off all accessories.
4. Connect the voltmeter positive (+) lead to the alternator output terminal. Connect the voltmeter negative (–) lead to the battery positive (+) post.

***NOTE:*** *Connect the voltmeter leads to the battery post, NOT the battery cable end.*

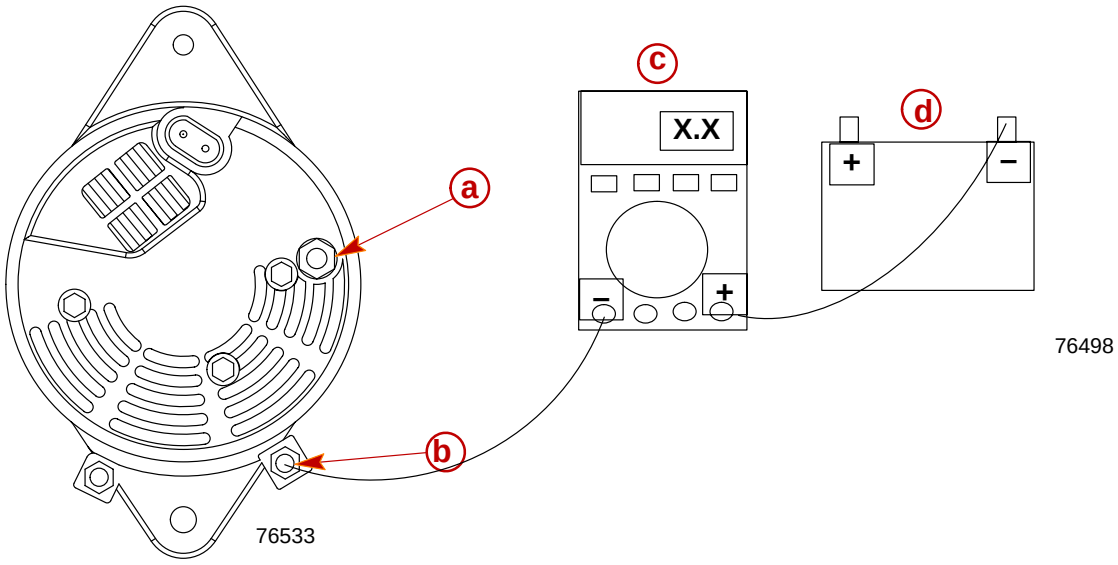



**Typical**

**a** - Output Terminal
**b** - Ground Terminal
**c** - Voltmeter
**d** - Battery

5. Start the engine and operate at 1300-1500 rpm. Read the voltmeter. A reading of more than 0.5 volts shows excessive resistance in the wiring.

6. Connect the voltmeter negative (–) lead to the alternator ground terminal. Connect the voltmeter positive (+) lead to the battery negative (–) post.




**Typical**

**a** - Output Terminal
**b** - Ground Terminal
**c** - Voltmeter
**d** - Battery

7. Repeat Step 5.

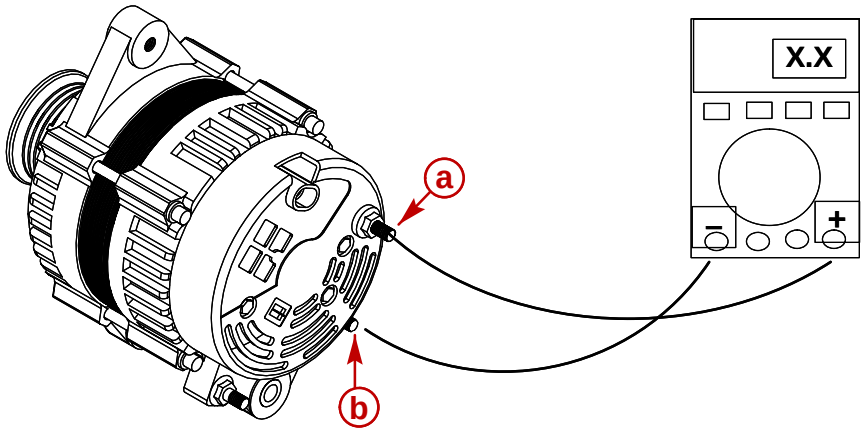
# Circuitry

Perform the following tests with a DMM to ensure that all of the circuits between the alternator and the other components within the charging system are in good condition.

1. Connect the DVOM positive (+) lead to the battery positive (+) post.
2. Connect the DVOM negative (-) lead to the battery negative (-) post.

## OUTPUT CIRCUIT

1. Start the engine and increase rpm to approximately 1300 rpm.
2. Observe the voltage reading.
3. If the reading is between 13.5 and 14.2 volts, switch the DVOM to the AC volt position. and observe. A reading of 0.25 AC volts or less indicates that the alternator diodes are fully functional. A reading above 0.25 AC volts indicates that the diodes are faulty and the alternator must be replaced.
4. If the reading is below 13.5 volts:
   a. Connect the positive (+) voltmeter lead to the alternator output post.
   b. Connect the negative (–) lead to the ground post on the alternator.
   c. Wiggle the engine wiring harness while observing the voltmeter. The meter should indicate the approximate battery voltage and should not vary. If no reading is obtained, or if the reading varies, refer to Resistance in this section.




78145

**a** - Output Wire - ORANGE
**b** - Ground

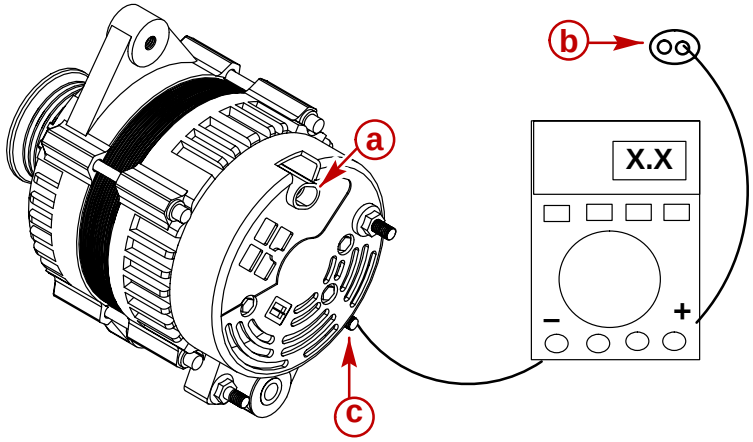
5. If the reading is above 15 volts, the alternator is overcharging and must be replaced.

## EXCITATION CIRCUIT

1. Connect the positive (+) voltmeter lead to the tie strap terminal on the alternator and the negative (–) lead to a ground terminal on the alternator.
2. Turn the ignition switch to the ON position and note the voltmeter reading. The reading should be 1.3 to 2.5 volts.
3. If no reading is obtained, an open exists in the alternator excitation lead or in the excitation circuit of the regulator. Unplug the PURPLE lead from the regulator. Connect the positive voltmeter lead to the PURPLE lead and the negative voltmeter leads to the ground. If the voltmeter now indicates the approximate battery voltage, the voltage regulator is defective and must be replaced. If no voltage is indicated, check the excitation circuit for loose or dirty connections or damaged wiring.

## SENSING CIRCUIT

1. Unplug the RED and RED/PUR connector from the alternator.
2. Connect the positive (+) voltmeter lead to the RED/PUR pin and the negative (–) voltmeter lead to the ground terminal.
3. The voltmeter should indicate the battery voltage. If battery voltage is not present, check the RED/PUR wire for loose or dirty connection or damaged wiring.




78146

**a** - Connector Location
**b** - RED and RED/PUR Connector
**c** - Ground

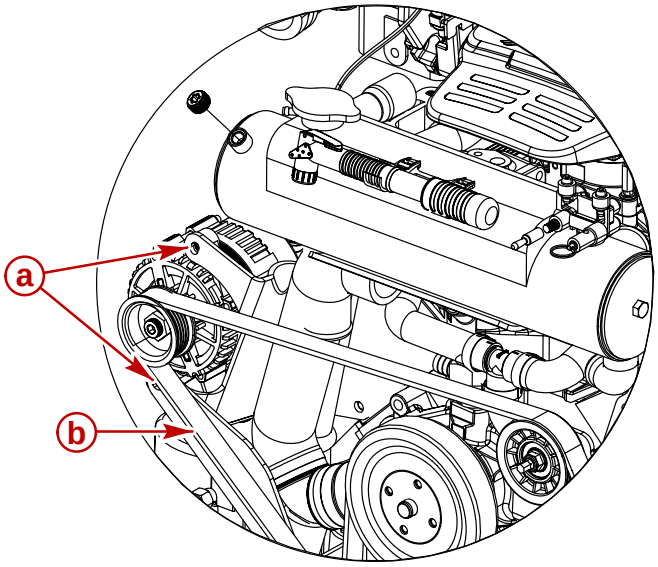
# Removal

## Alternator

**⚠ WARNING**

**Avoid injury or death and power package damage from an electrical shock, fire or explosion. Always disconnect both battery cables from the battery before servicing the power package.**

1. Disconnect both battery cables from the battery.
2. Disconnect the lead and ground wires.
3. Disconnect the excitation wire.
4. Remove the drive belt.
5. Remove the alternator mounting bolts and the washers.




78114

**a** - Mounting Bracket
**b** - Serpentine Belt

6. Remove the alternator.

## Alternator Bracket

1. Drain the cooling system.
2. Remove the water circulating pump hose.
3. Remove the bracket

# Installation

## Alternator Bracket

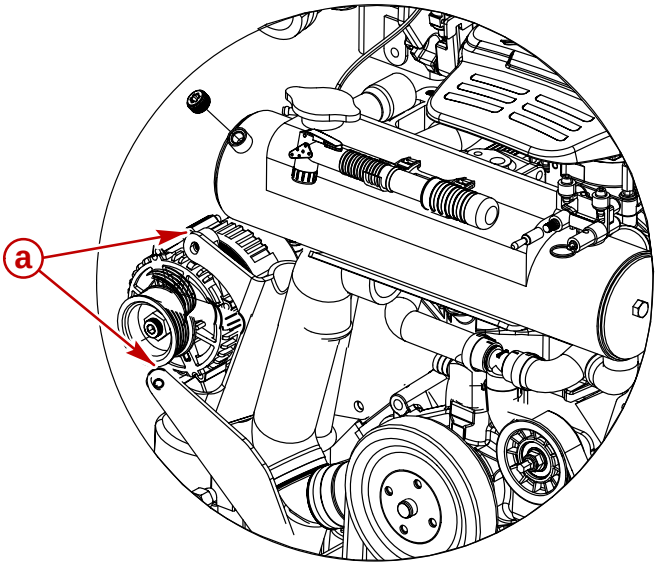
1. Install the alternator bracket

| Description | Nm | lb-in. | lb-ft |
|---|---|---|---|
| Alternator Mounting Bracket | 41 | | 30 |

2. Install the water circulating pump hope and securely tighten the hose clamps.

## Alternator

1. Install the idler brace.
2. Position the alternator in the mounting bracket.
3. Install the mounting bolts and torque.



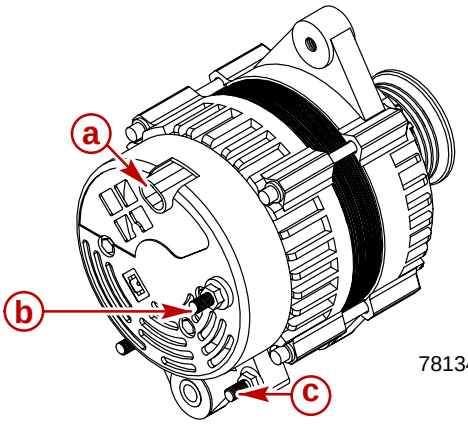

78114

**a -** MCM Mounting Bracket

| Description | | Nm | lb-in. | lb-ft |
|---|---|---|---|---|
| Mounting Bolts | M8 x 1.25 | 11 | | 8 |

4. Position the alternator drive belt on the pulleys and adjust the tension.

5. Reconnect the wiring harness to the alternator.



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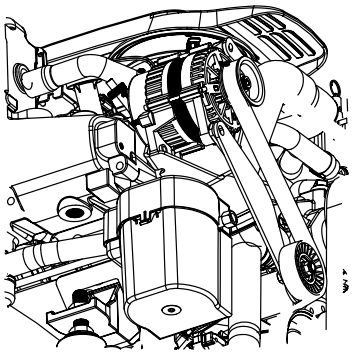
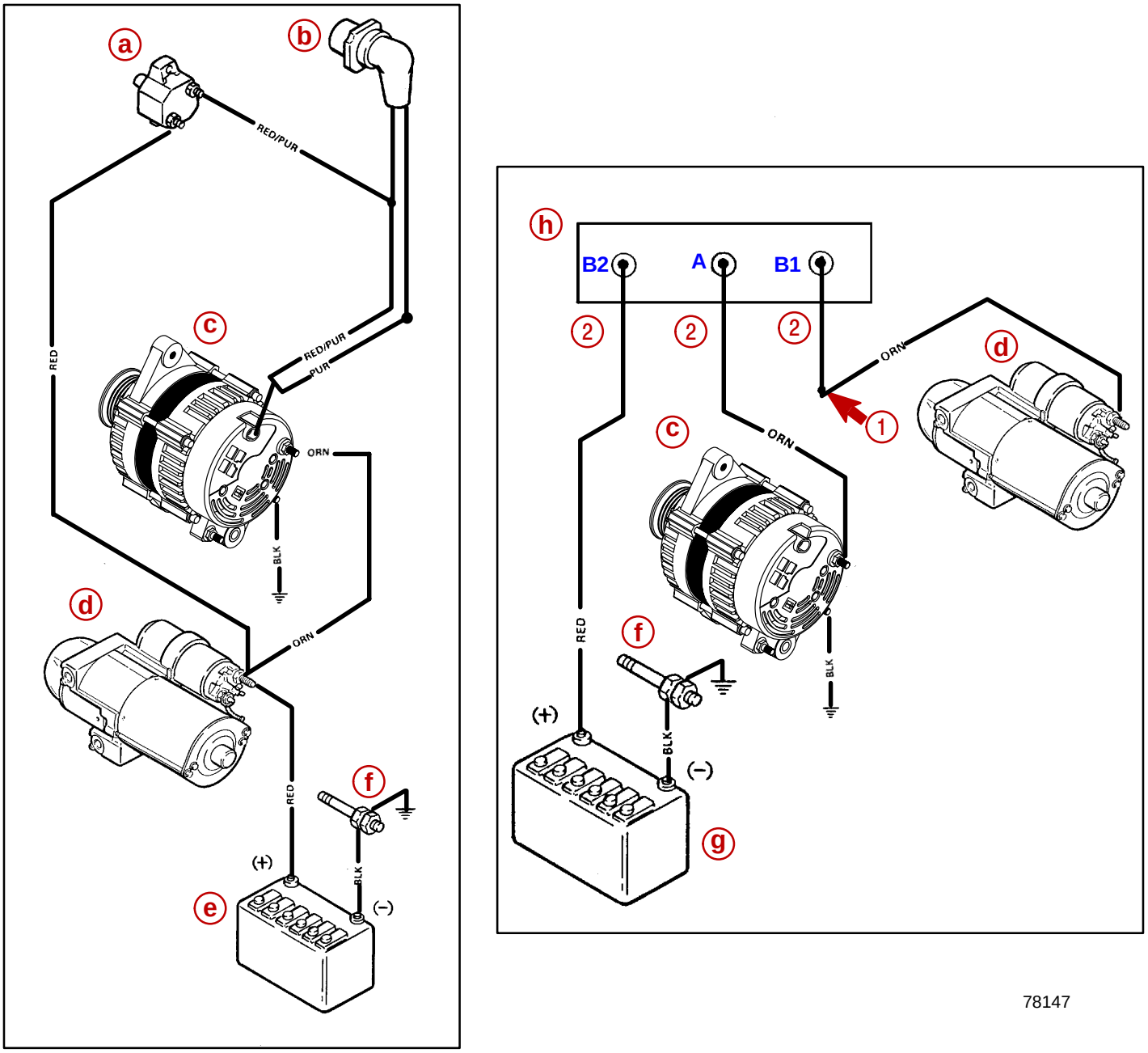

77945

**a** - RED and RED/PURPLE Connector
**b** - ORG Wire
**c** - Ground

6. Connect the both battery cables to the battery.
7. Fill the cooling system with the correct fluid.

# Battery Isolator Diagram




**a** - Circuit Breaker
**b** - Harness Connector
**c** - Alternator
**d** - Starter
**e** - Cranking Battery
**f** - Ground Stud
**g** - Auxiliary Battery
**h** - Isolator

**1** - Disconnect ORANGE Wire From Alternator Battery Terminal. Splice Sufficient Gauge Wire To The Orange Wire And Connect As Shown.
**2** - 8 Gauge Minimum

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# ELECTRICAL SYSTEM

## Section 4D - Wiring Diagrams

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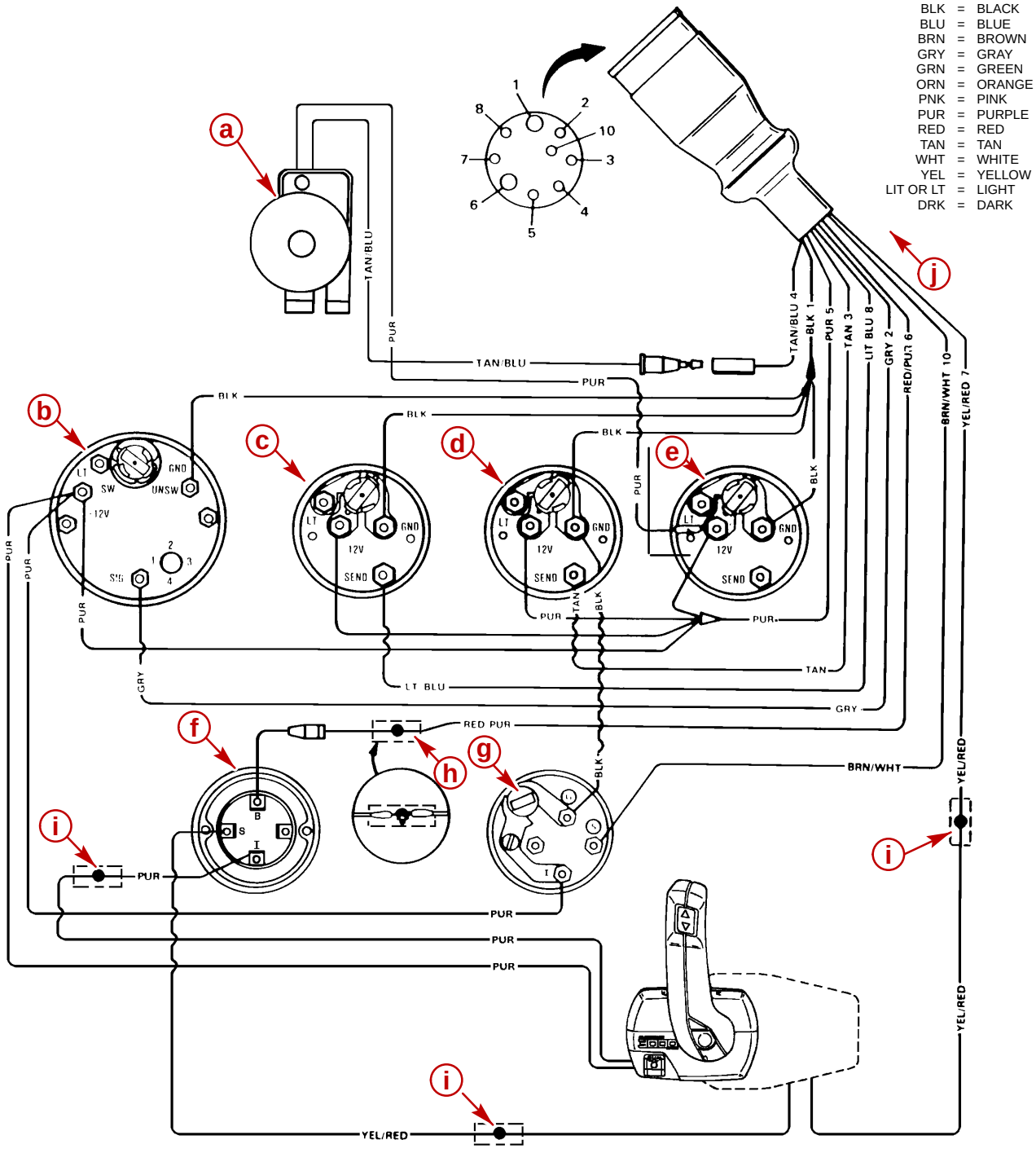
| Single Station Installations - Typical . | 4D-2 | Wiring Diagrams . . . . . | 4D-6 |
| Power Trim System . . . . . | 4D-4 | | |


4 D

# Instrumentation

## Single Station Installations - Typical




74583

Refer to gauge manufacturer's instructions for specific connections.

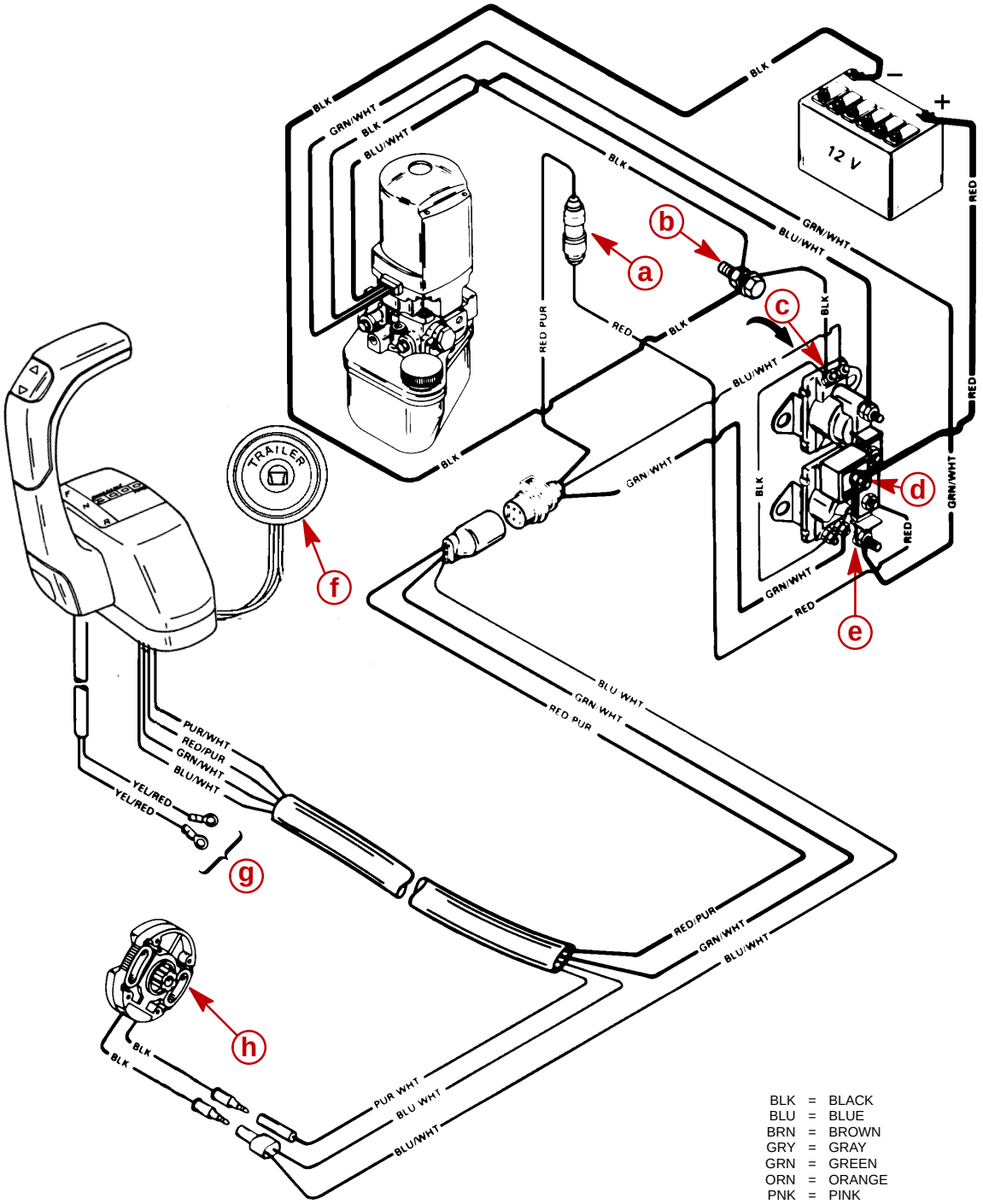
***NOTE:*** [1] *Connect Wires Together with Screw and Hex Nut; Apply Liquid Neoprene to Connection and Slide Rubber Sleeve over Connection.*

***NOTE:*** [2] *Power for a Fused Accessory Panel May Be Taken from This Connection. Load Must Not Exceed 40 Amps. Panel Ground Wire Must Be Connected to Instrument Terminal That Has an 8-Gauge Black (Ground) Harness Wire Connected to it.*

***NOTE:*** [3] *Lanyard stop switch lead and neutral safety switch leads must be soldered and covered with shrink tube for a water proof connection. If an alternate method of connection is made, verify connection is secure and sealed for a water proof connection.*

- **a** - Audio Warning Alarm
- **b** - Tachometer
- **c** - Oil Pressure
- **d** - Water Temperature
- **e** - Battery Meter
- **f** - Ignition Switch
- **g** - Trim Indicator
- **h** - Read/Observe NOTE 1 and 2.
- **i** - Read/Observe NOTE 3.
- **j** - To Engine Wiring Harness

# Power Trim System

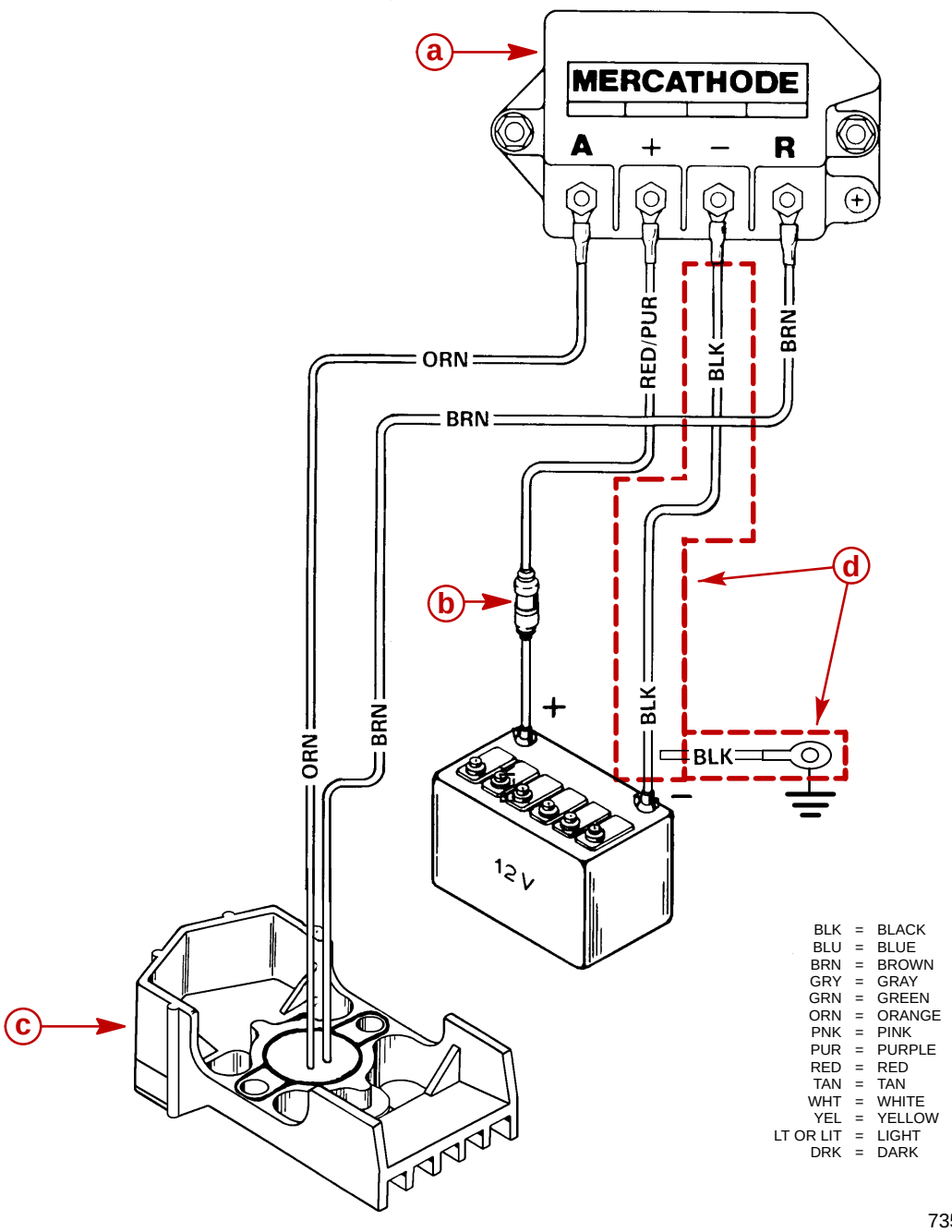



| | | |
|---|---|---|
| BLK | = | BLACK |
| BLU | = | BLUE |
| BRN | = | BROWN |
| GRY | = | GRAY |
| GRN | = | GREEN |
| ORN | = | ORANGE |
| PNK | = | PINK |
| PUR | = | PURPLE |
| RED | = | RED |
| TAN | = | TAN |
| WHT | = | WHITE |
| YEL | = | YELLOW |
| LT OR LIT | = | LIGHT |
| DRK | = | DARK |

73962

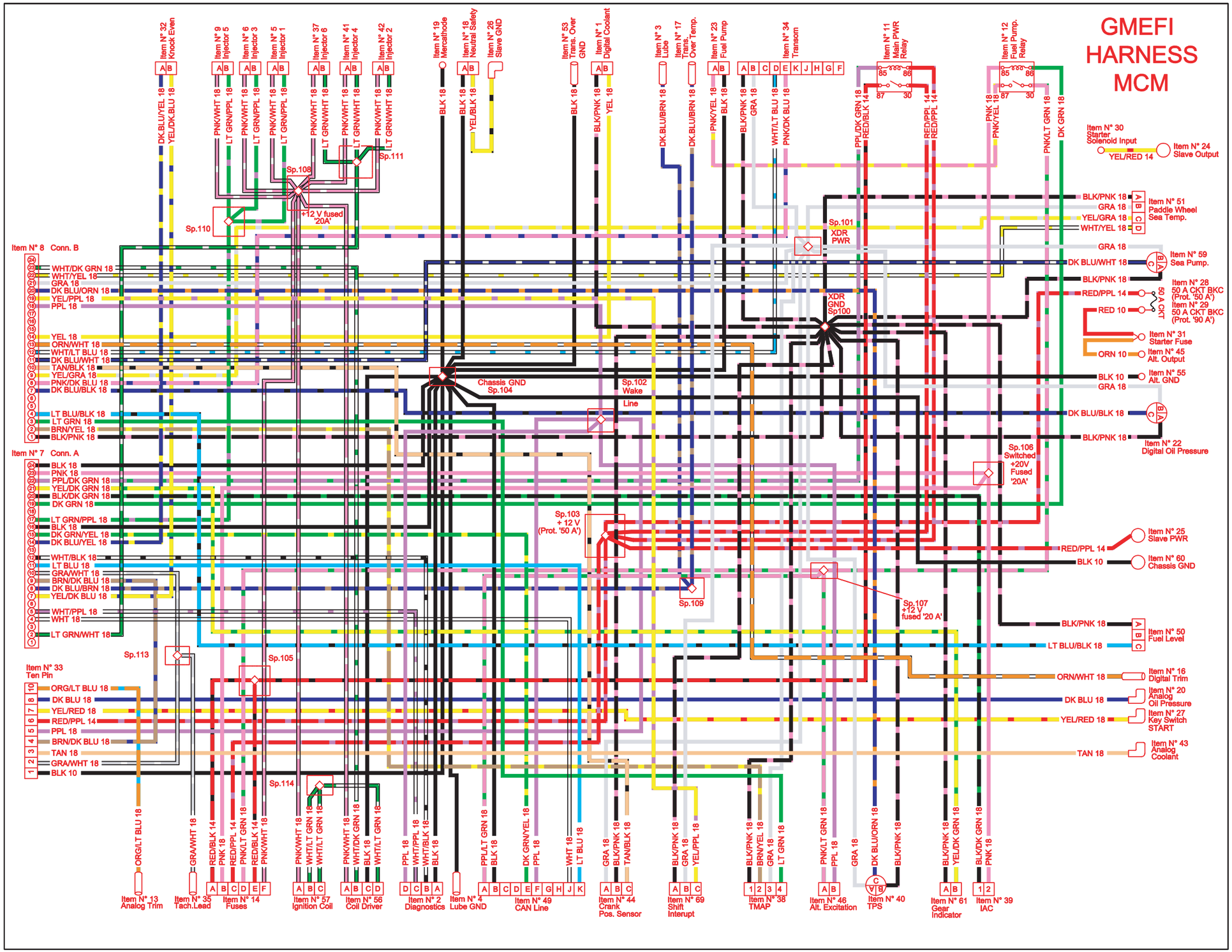
**a** - 20 Amp Fuse
**b** - Ground Bolt (Floor Mount)
**c** - UP Solenoid
**d** - 110 Amp Fuse
**e** - DOWN Solenoid
**f** - Trailer Switch
**g** - Neutral Switch to Instrument Wiring Harness
**h** - Trim Limit Switch

# MerCathode System Wiring Diagram




**a** - Controller
**b** - 20 Amp Fuse
**c** - Electrode
**d** - BLACK Wire - With Engine Harness or Separate

# Wiring Diagrams


GMEFI
HARNESS
MCM
Item N° 32 Knock Even
Item N° 9 Injector 5
Item N° 6 Injector 3
Item N° 5 Injector 1
Item N° 37 Injector 6
Item N° 41 Injector 4
Item N° 42 Injector 2
Item N° 19 Mercathode
Item N° 18 Neutral Safety
Item N° 26 Slave GND
Item N° 53 Trans. Over GND
Item N° 1 Digital Coolant
Item N° 3 Lube
Item N° 17 Trans. Over Temp.
Item N° 23 Fuel Pump
Item N° 34 Transom
Item N° 11 Main PWR Relay
Item N° 12 Fuel Pump. Relay
Item N° 30 Starter Solenoid Input
YEL/RED 14
Item N° 24 Slave Output
Sp.108
Sp.111
Sp.110
+12 V fused '20A'
Sp.101 XDR PWR
XDR GND Sp100
Chassis GND Sp.104
Sp.102 Wake Line
Sp.103 + 12 V (Prot. '50 A')
Sp.109
Sp.107 +12 V fused '20 A'
Sp.106 Switched +20V Fused '20A'
Sp.105
Sp.113
Sp.114
Item N° 8 Conn. B
Item N° 7 Conn. A
Item N° 33 Ten Pin
Item N° 51 Paddle Wheel Sea Temp.
Item N° 59 Sea Pump.
Item N° 28 50 A CKT BKC (Prot. '50 A')
Item N° 29 50 A CKT BKC (Prot. '90 A')
Item N° 31 Starter Fuse
Item N° 45 Alt. Output
Item N° 55 Alt. GND
Item N° 22 Digital Oil Pressure
Item N° 25 Slave PWR
Item N° 60 Chassis GND
Item N° 50 Fuel Level
Item N° 16 Digital Trim
Item N° 20 Analog Oil Pressure
Item N° 27 Key Switch START
Item N° 43 Analog Coolant
Item N° 13 Analog Trim
Item N° 35 Tach.Lead
Item N° 14 Fuses
Item N° 57 Ignition Coil
Item N° 56 Coil Driver
Item N° 2 Diagnostics
Item N° 4 Lube GND
Item N° 49 CAN Line
Item N° 44 Crank Pos. Sensor
Item N° 69 Shift Interupt
Item N° 38 TMAP
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Item N° 40 TPS
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Item N° 39 IAC

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# FUEL SYSTEM

## Section 5A - Fuel System

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  Fuel Pump Relay . . . . . 5A-50
  Main Power Relay . . . . . 5A-51


5A

# Specifications

| Description | Specification |
|---|---|
| Fuel Pump Pressure | 43 psi (296.5 kPa) |

# Torque Specifications

| Description | | Nm | lb-in. | lb-ft |
|---|---|---|---|---|
| Distributor Hold Down Clamp Bolt | | 25 | | 18 |
| Engine Coolant Temperature Sensor (ECT) | | 20 | | 15 |
| Nut, Flame Arrestor Retainer Bracket | | 12 | 108 | |
| Fuel Inlet Fitting | | Finger tight + 1-3/4 to 2-1/4 turns with a wrench. Do NOT overtighten. | | |
| Fuel Lines | | 24 | | 19 |
| Fuel Rail Bracket Bolt | | 6 | 53 | |
| Nuts, Fuel Rail Retainer | | 3 | 27 | |
| Nuts, IAC Bracket | | 15 | 132 | |
| IAC To Bracket Bolts | | 19 | 168 | |
| IAC Plug To Throttle Body Screws | | 3 | 24 | |
| Idle Air Control Valve (IAC) | | 2 | 20 | |
| Ignition Coil Studs | | 12 | 106 | |
| Knock Sensor to Block | | 20 | | 15 |
| Lower Intake Manifold Bolt (Each Pass In Sequence) | | | | |
| | First Pass | 3 | 27 | |
| | Second Pass | 12 | 106 | |
| | Final Pass | 15 | 132 | |
| Manifold Air Pressure and Temperature Sensor (MAPT) | | 6 | 53 | |
| Nuts, Engine Mount Studs | | 41 | | 30 |
| Fuel Pressure Regulator Screws | | 5.8 | 53 | |
| Nuts, Retainer Bracket | | 5.6 | 50 | |
| Stepped Screw | | 9 | 81 | |
| Nuts, Throttle Body | | 10 | 88 | |
| Studs, Throttle Body | | 9 | 80 | |
| Nuts, Throttle Cable Bracket | | 19 | 168 | |
| Throttle Position Sensor (TPS) | | 2 | 20 | |
| Studs, Upper Intake Manifold | | | | |
| | First Pass | 5 | 44 | |
| | Final Pass | 10 | 89 | |

# Special Tools

| Description | Part Number |
|---|---|
| Fuel Pressure Gauge | Obtain Locally |

# Lubricants / Sealants / Adhesives

| Description | Where Used | Part Number |
|---|---|---|
| Thermal Grease | Cool Fuel Retainer Bracket | Obtain Locally |
| Loctite 242 | Throttle Body Studs, Fuel Cooler Mounting Studs, Lower Intake Manifold Bolts | 92-809824 |
| Loctite 592 Pipe Sealant With Teflon | Fuel Fittings | Obtain Locally |
| Engine Oil | Filter Sealing Ring | Obtain Locally |
| Ultra Black Loctite 5900 | Lower Intake Manifold Gaskets, Engine Block at Lower Intake Manifold Sealing Surfaces | 92-809826 |

# Replacement Parts Warning

**⚠ WARNING**

**Electrical, ignition and fuel system components on your MerCruiser are designed and manufactured to comply with U.S. Coast Guard Rules and Regulations to minimize risks of fire and explosion.**

**Use of replacement electrical, ignition or fuel system components, which do not comply with these rules and regulations, could result in a fire or explosion hazard and should be avoided.**

# Abbreviations

| | |
|---|---|
| amp | Amperes |
| Bat | Battery Positive Terminal, Battery or System Voltage |
| B+ | Battery Positive |
| CMP | Camshaft Position Sensor |
| CPS | Crankshaft Position Sensor |
| Deg | Degrees |
| DMM<br>DMT<br>DVM<br>DVOM | Digital Multimeter |
| ECM | Engine Control Module |
| ECT | Engine Coolant Temperature |
| EFI | Electronic Fuel Injector |
| ENG | Engine |
| GND | Ground |
| IAC | Idle Air Control |
| in. hg | Inches Of Mercury |
| INJ | Injection |
| kPa | Kilopascal |
| mA | milliamperes |
| MPR | Main Power Relay |
| MAPT | Manifold Air Pressure and Temperature |
| mohms | Milliohms |
| mSec | Millisecond |
| TACH | Tachometer |
| TERM | Terminal |
| TPS | Throttle Position Sensor |
| V | Volts |
| WOT | Wide Open Throttle |

# Precautions

**⚠ WARNING**

**Avoid personal injury or death and power package damage from an electrical shock, fire or explosion. Always disconnect both battery cables from the battery before servicing the power package.**

**⚠ WARNING**

**Be careful when changing fuel system components; gasoline is extremely flammable and highly explosive under certain conditions. Be sure that ignition key is OFF. Do NOT smoke or allow sources of spark or flame in the area while changing fuel filters. Wipe up any spilled fuel immediately.**

**⚠ WARNING**

**Make sure that no fuel leaks exist before closing engine hatch.**

**⚠ CAUTION**

**Do NOT operate engine without cooling water being supplied to seawater pickup pump or pump impeller will be damaged and subsequent overheating damage may result.**

**⚠ WARNING**

**Fuel vapors can be present in the engine compartment. Avoid injury or power package damage caused by fuel vapors or explosion. Always ventilate the engine compartment prior to servicing the power package.**

# Fuel Supply Connections

**⚠ WARNING**

**Avoid gasoline fire or explosion. Improper installation of brass fittings or plugs into fuel pump or fuel filter base can crack casting and/or cause a fuel leak.**

- **Apply #592 Loctite Pipe Sealant with Teflon to threads of brass fitting or plug. Do NOT use teflon tape.**
- **Thread brass fitting or plug into fuel pump or fuel filter base until finger tight.**
- **Tighten fitting or plug an additional 1-3/4 to 2-1/4 turns using a wrench. Do NOT overtighten.**
- **Install fuel line. To prevent overtightening, hold brass fitting with suitable wrench and tighten fuel line connectors securely.**
- **Check for fuel leaks.**

# Fuel Delivery System

## Recommendations

**⚠ WARNING**

**Boating standards (NMMA, ABYC, etc.) and Coast Guard regulations must be adhered to when installing fuel delivery system.**

The Fuel Tank is an integrated component of the boat. Refer to the special information on service and maintenance, which you have received from the tank or boat manufacturer.

***NOTE: On Ski Boat Applications:*** *If during testing for a particular application, you experience fuel starvation in sharp high speed turns, baffles or a fuel sump may be needed in the tank to help correct this condition.*

All fuel lines must be well secured. The holes where the lines go through the bulkheads should be carefully rounded off or protected with rubber grommets. This prevents damage to the lines from abrasion.

The following, but not limited to the following, additional fuel connection related points, *applying to all engines unless otherwise stated*, must be considered. Refer to boating standards (NMMA, ABYC, etc.) and Coast Guard regulations for complete guidelines.

1. Fuel pickup should be at least 25 mm (1 in.) from the bottom of fuel tank to prevent picking up impurities.
2. Fuel lines used must be Coast Guard approved (USCG Type A1).
3. Diameter of fittings and lines ~~must be smaller than~~ 10 mm (3/8 in.) ID.

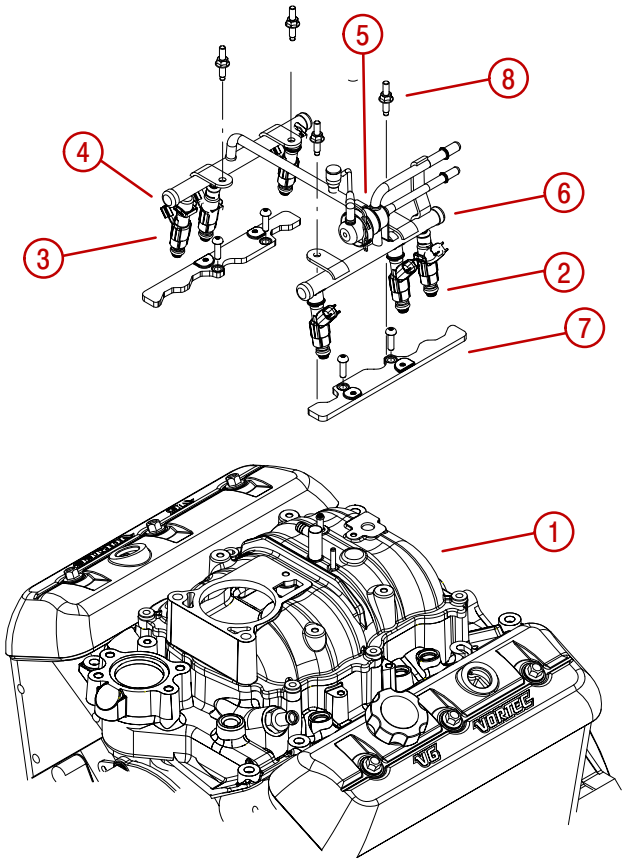
   correction: MINIMUM fuel size is 10 mm (3/8 in.)
4. **On Multi-Engine Gasoline Installations:** It is best to use a fuel pickup and supply line for **each** engine. If a single pickup and line is used, the line must be 13 mm (1/2 in.) ID or larger.
5. Larger diameter (than previously specified) lines and fittings must be used on installations requiring long lines or numerous fittings.
6. Fuel lines should be installed free of stress and firmly secured to prevent vibration and/or chafing.
7. Sharp bends in fuel lines should be avoided.
8. A flexible fuel line must be used to connect fuel supply line to fuel inlet fitting on engine to absorb deflection when engine is running.

**IMPORTANT: Vacuum reading higher than specified can cause vapor locking with some of today's fuels. It can also cause poor engine performance due to fuel starvation.**

9. The maximum measured vacuum at engine fuel inlet must not exceed 6.9 kPa (2 in. Hg) at 650, 3000, WOT and idle rpm.

# Exploded Views

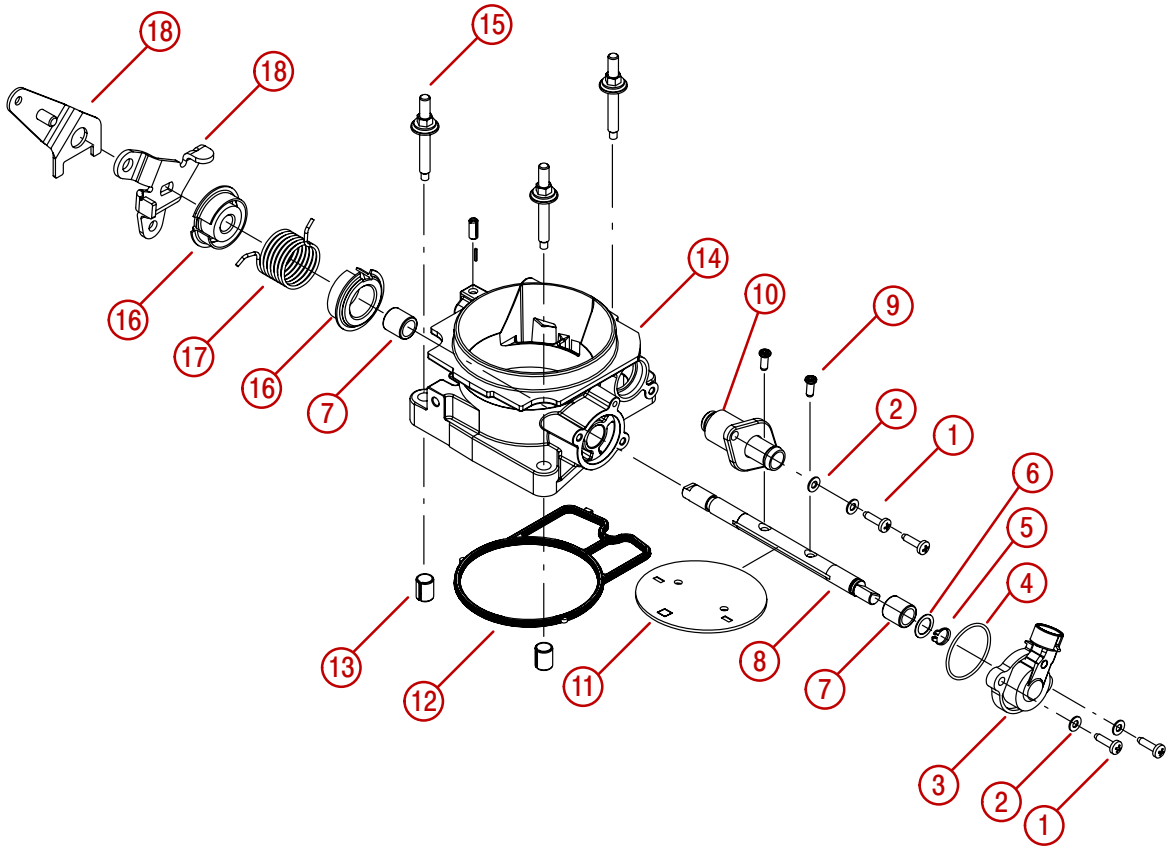
## Fuel Rail and Injectors




78268

**1** - Intake Manifold
**2** - O-rings (6)
**3** - Fuel Injectors (6)
**4** - Fuel Injector Retainer Clip
**5** - Schrader Valve (Fuel Pressure Relief)
**6** - Fuel Rail
**7** - Guide
**8** - Fuel Rail Studs

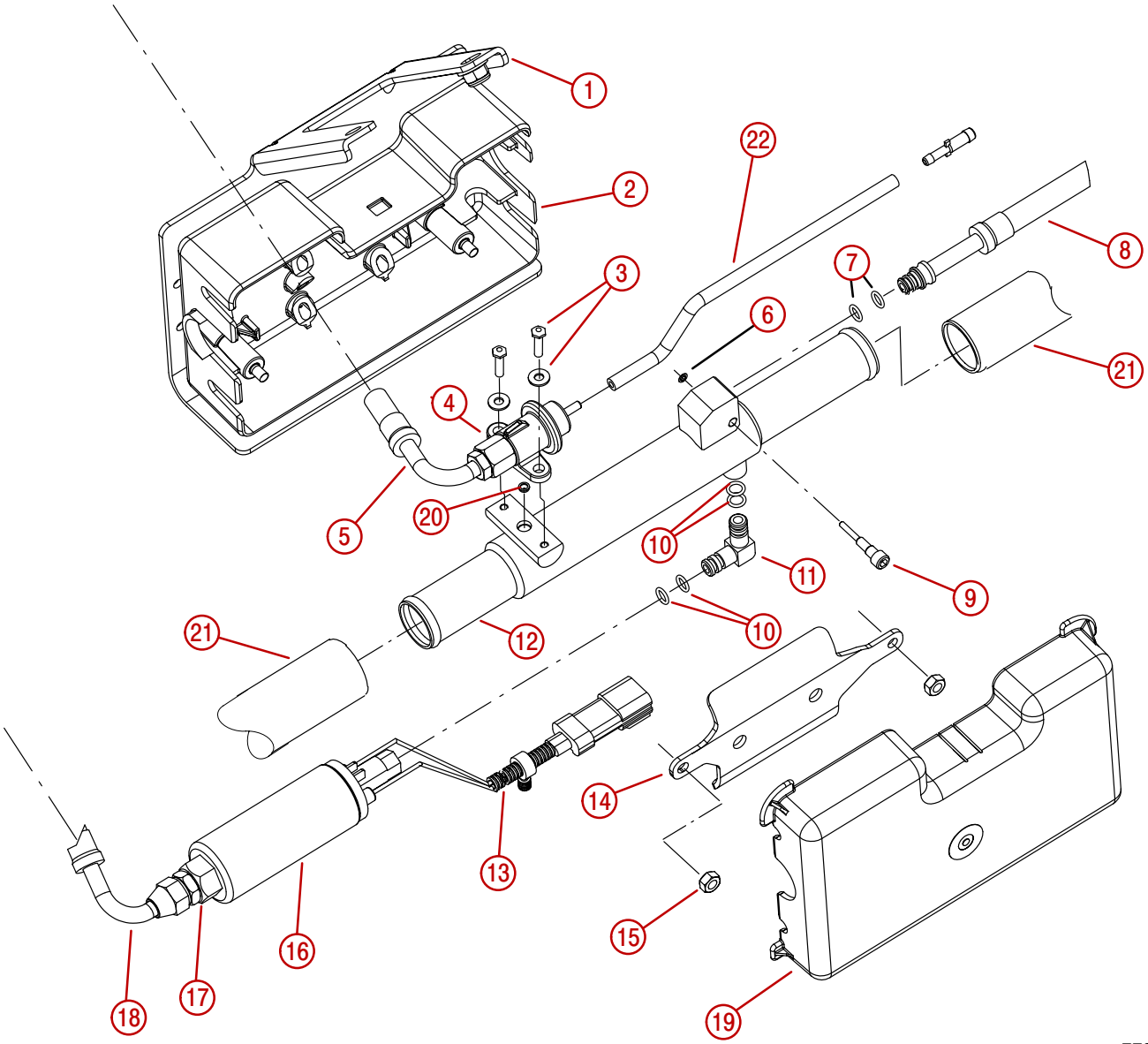
# Throttle Body




77840

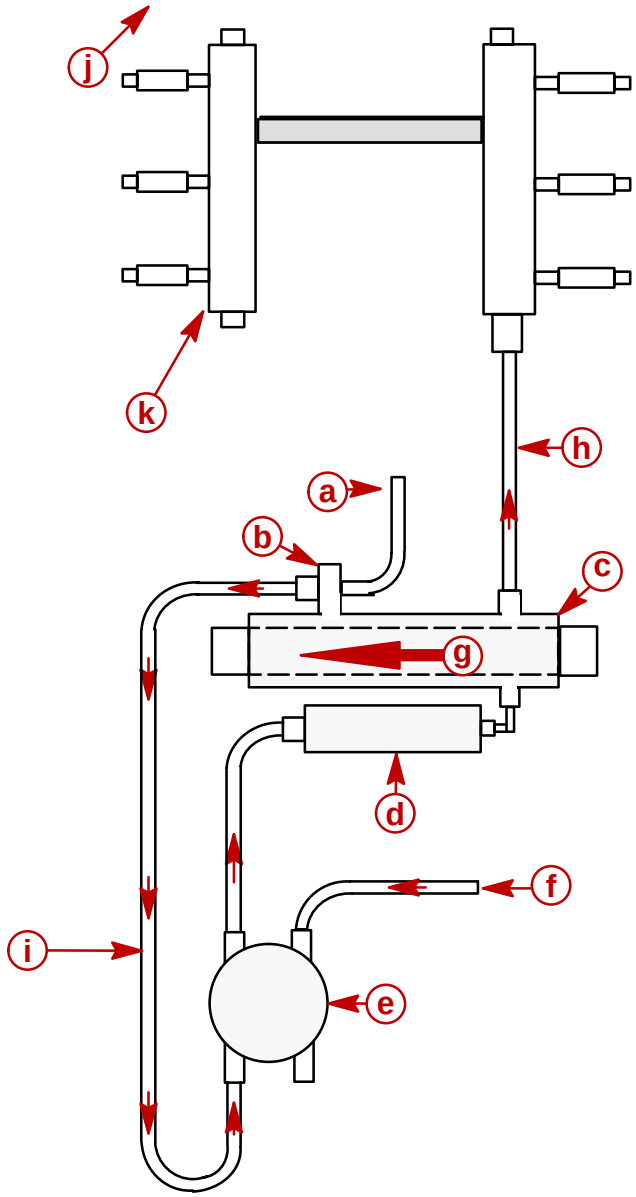
**1 -** Bolt (2)
**2 -** Washer (2)
**3 -** Throttle Position Sensor
**4 -** O-ring
**5 -** C-clip
**6 -** Washer
**7 -** Spacer
**8 -** Throttle Plate Bar
**9 -** Rivet (2)
**10 -** IAC Plug
**11 -** Throttle Plate
**12 -** Sealing Ring
**13 -** Alignment Dowels (2)
**14 -** Throttle Body
**15 -** Throttle Body Studs (3)
**16 -** Spring Cover
**17 -** Spring
**18 -** Throttle Cable Bracket

# Cool Fuel System




**1 -** Bracket
**2 -** Cover Base
**3 -** Screw And Washer (2)
**4 -** Fuel Pressure Regulator
**5 -** Return Fuel Line
**6 -** Retaining Ring
**7 -** O-rings (2)
**8 -** Fuel Line, Fuel Pump-To-Fuel Rail
**9 -** Stepped Screw
**10 -** O-rings (4)
**11 -** Elbow Fitting
**12 -** Fuel Cooler
**13 -** Fuel Pump Wiring Harness
**14 -** Retainer Bracket
**15 -** Nut (2)
**16 -** Electric Fuel Pump
**17 -** Inlet Fitting
**18 -** Fuel Line Inlet
**19 -** Cover
**20 -** Filter
**21 -** Seawater Hoses (Hose Clamps Not Shown)
**22 -** Vacuum Hose

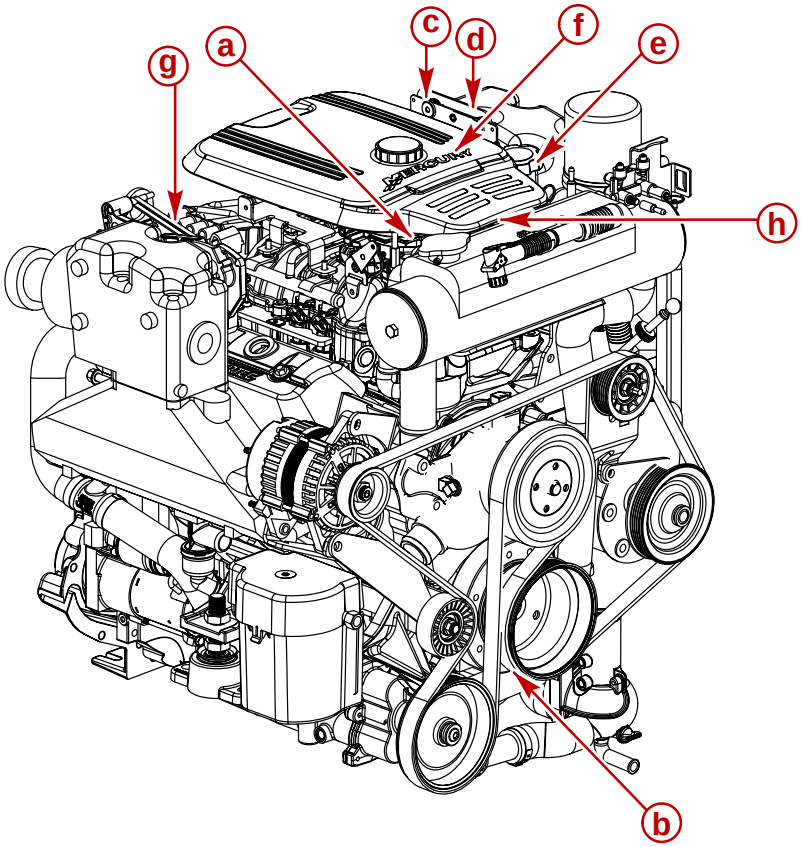
# Fuel System Flow Diagrams




78269

**a** - Vacuum Line To Intake Manifold Base
**b** - Fuel Pressure Regulator
**c** - Fuel Cooler
**d** - Electric Fuel Pump
**e** - Water Separating Fuel Filter
**f** - Fuel From Tank
**g** - Water Flow
**h** - Fuel Line To Fuel Rail
**i** - Excess Fuel Return To Water Separating Fuel Filter
**j** - Fuel Injectors (6)
**k** - Fuel Rail

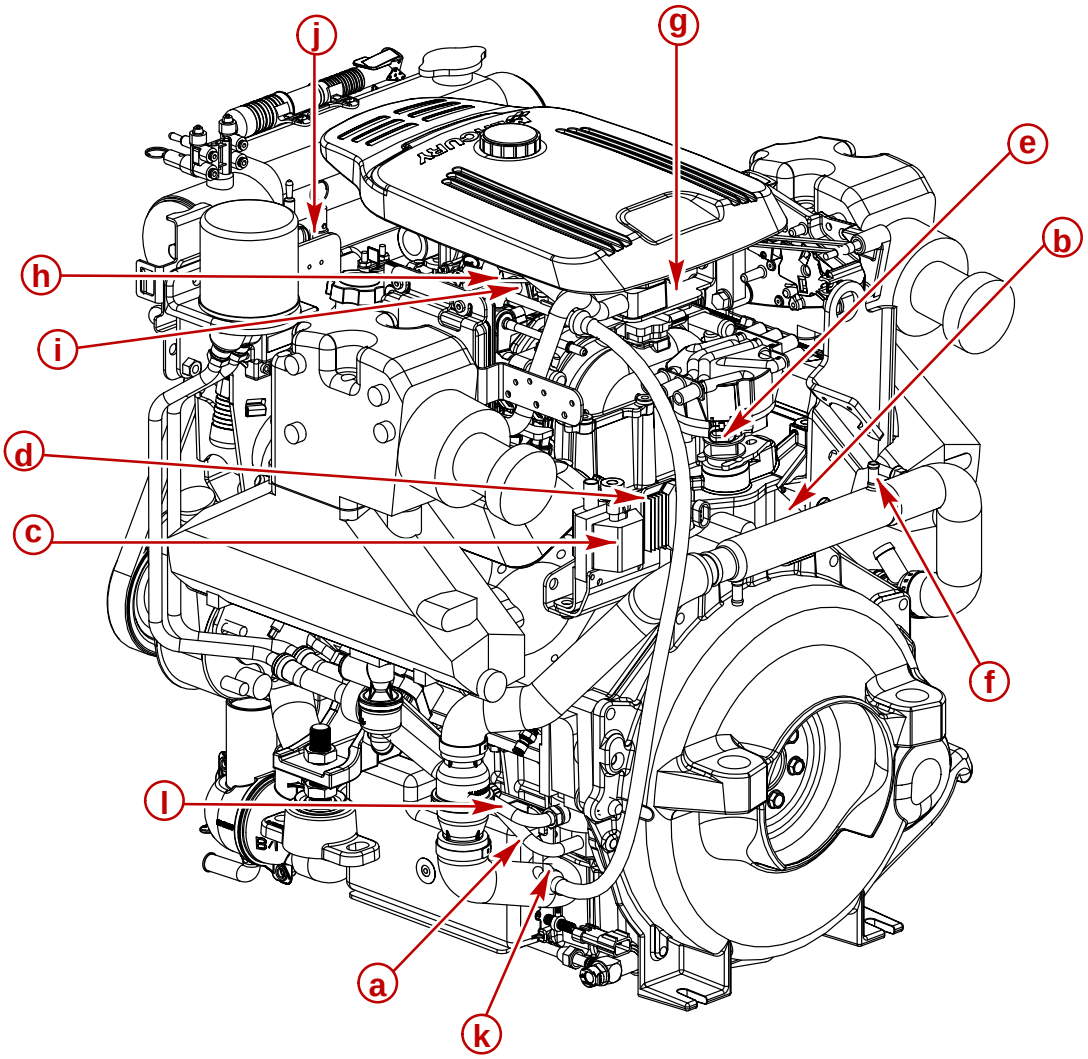
# Sensor Locations




77812

**a** - Water Temperature Switch
**b** - Crank Sensor
**c** - Relays
**d** - ECM
**e** - DLC
**f** - Throttle Position Sensor (TPS)
**g** - Shift Interrupt Switch (Alpha) And Gear Indication Switch (Alpha And Bravo)
**h** - Water Temperature Sender

# Sensor Locations (continued)




77811

**a** - Cool Fuel Harness Connector
**b** - Knock Sensor
**c** - Ignition Coil
**d** - Ignition Module
**e** - Distributor Connector (Should Be Capped)
**f** - Water Transducer
**g** - Manifold Air Pressure / Temperature
**h** - Circuit Breaker
**i** - Idle Air Control
**j** - MerCathode Controller
**k** - Oil Pressure Switch
**l** - Oil Pressure Sender

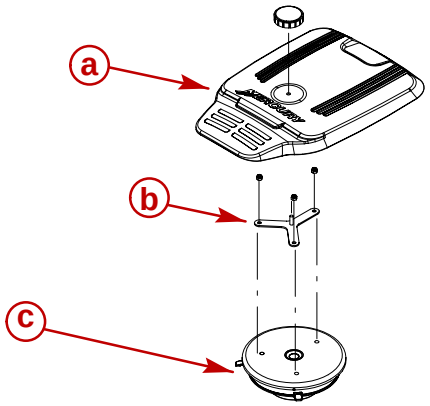
# Fuel Pressure Relief Procedure

1. Activate the Schrader valve located on the fuel rail to release pressure.

# Flame Arrestor

## Removal

1. Remove the engine cover.
2. Remove the flame arrestor retainer bracket.
3. Remove the flame arrestor from the throttle body.




78268

**a** - Engine Cover
**b** - Retainer Bracket
**c** - Flame Arrestor

## Cleaning and Inspection

1. Clean flame arrestor in steam or water.
2. Wear eye protection. Dry flame arrestor with compressed air.

## Installation

1. Install the flame arrestor on the throttle body.
2. Install the flame arrestor retainer bracket.

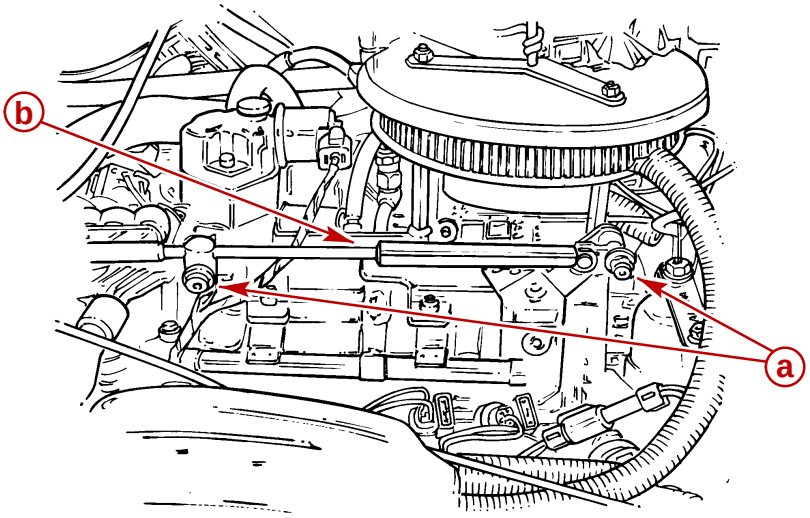
| Description | Nm | lb-in. | lb-ft |
|---|---|---|---|
| Nut, Flame Arrestor Retainer Bracket | 12 | 108 | |

3. Install the engine cover.

# Throttle Body

## Removal

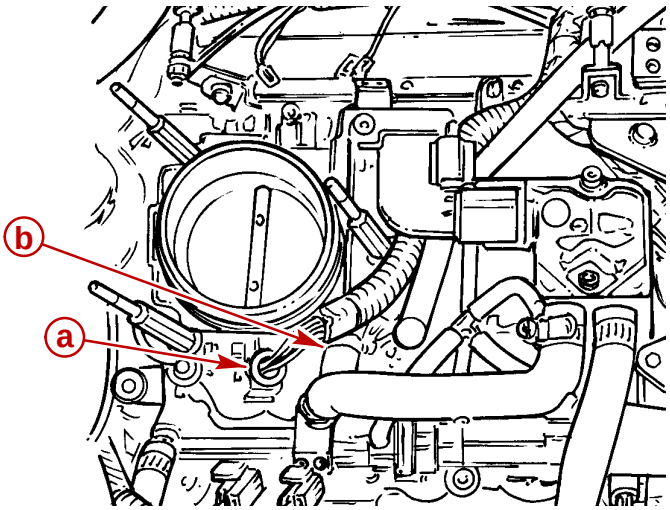
1. Remove the engine cover and the flame arrestor.
2. Disconnect the throttle linkage from the throttle body.




78033

**a** - Nuts
**b** - Throttle Cable

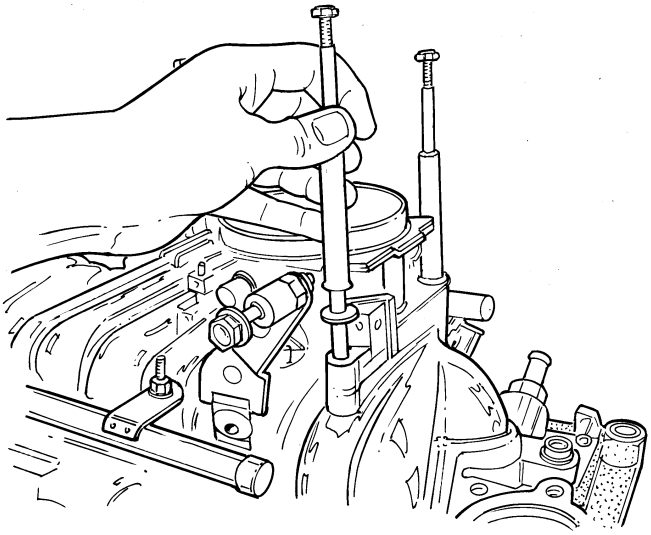
3. Disconnect the harness connector from the throttle position sensor.
4. Remove the IAC hose from the throttle body.




77906

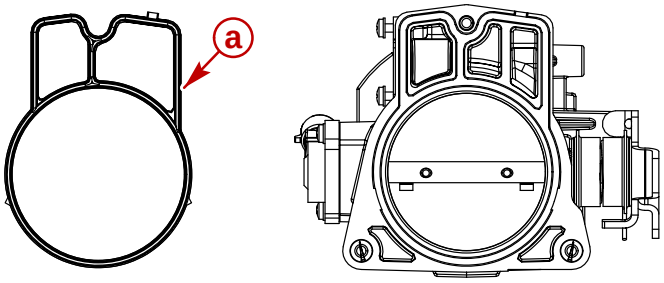
**a** - Throttle Position Sensor
**b** - IAC Hose

5. Remove the throttle body attaching studs.



78161

6. Remove the throttle body.
7. Remove and discard the throttle body sealing ring.




78158

**a** - Sealing Ring

**IMPORTANT: Insert a clean shop towel into the opening of the intake manifold to prevent foreign material from entering the engine.**

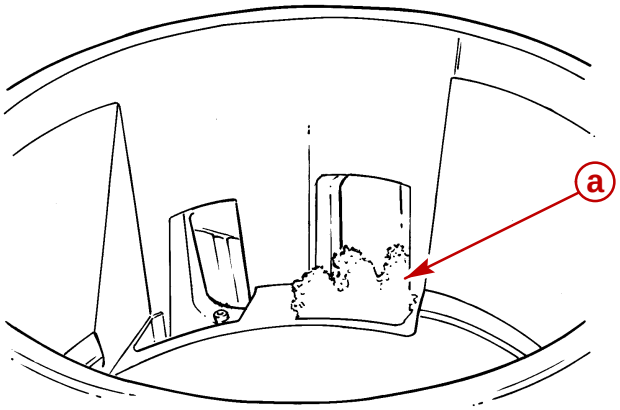
# Cleaning and Inspection

**IMPORTANT: Do NOT use cleaners containing methyl ethyl ketone.**

**IMPORTANT: Do NOT get solvent or cleaner on the TPS.**

**IMPORTANT: Do NOT damage the adapter and throttle body when removing gasket material from adapter and throttle body.**

1. Carefully remove all gasket material from adapter and throttle body.
2. Remove the IAC muffler.




77927

**a -** IAC Muffler Installed In Throttle Body

3. Thoroughly clean all parts of throttle body. Ensure that all passages are free of dirt and burrs.
4. Inspect mating surfaces for damage that could affect gasket sealing.
5. Inspect throttle body for cracks in casting.
6. Inspect throttle plates, linkage, return springs and other components for damage, wear and foreign material.

## Installation

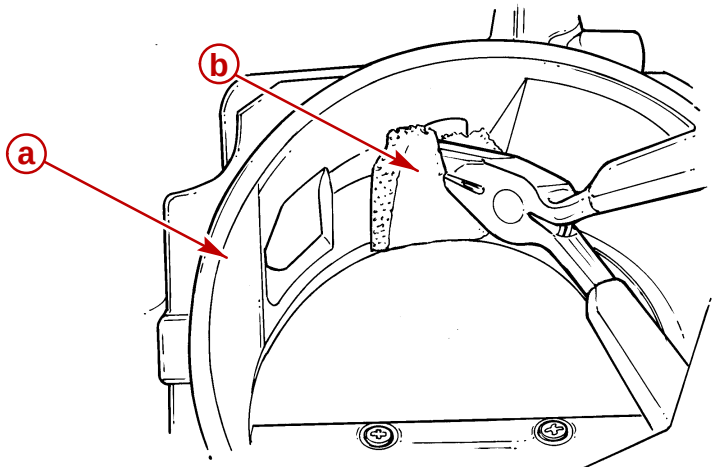
1. Install a new throttle body sealing ring into the groove in the throttle body.
2. Align the dowels and install the throttle body onto the upper intake manifold.
3. If reusing the fasteners, apply adhesive to the threads of the throttle body attaching studs.

| Description | Where Used | Part Number |
|---|---|---|
| Loctite 242 | Throttle Body Studs | 92-809821 |

4. Install the throttle body attaching studs. Torque the studs.

| Description | Nm | lb-in. | lb-ft |
|---|---|---|---|
| Studs, Throttle Body | 9 | 80 | |

5. Install the IAC muffler.




77926

**a** - Throttle Body
**b** - IAC Muffler

6. Install the throttle cable bracket.

***NOTE:*** *Ensure that the stud and nut are threading correctly.*

| Description | Nm | lb-in. | lb-ft |
|---|---|---|---|
| Nuts, Throttle Cable Bracket | 19 | 168 | |

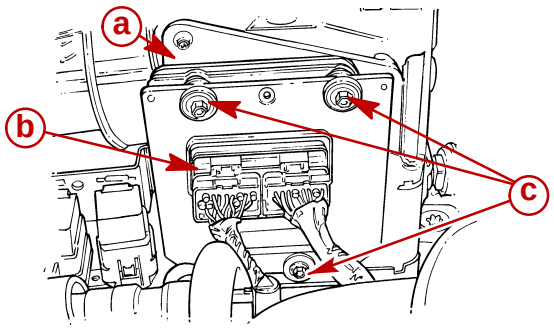
7. Install the IAC hose to the IAC plug.
8. Install the flame arrestor.

| Description | Nm | lb-in. | lb-ft |
|---|---|---|---|
| Nut, Flame Arrestor Retainer Bracket | 12 | 108 | |

9. Install the engine cover.

# Electronic Control Module (ECM)

**IMPORTANT: The ECM is a sensitive electrical device, subject to electrostatic damage. Do NOT touch connector pins when removing or installing the module.**




78019

**a -** ECM Bracket
**b -** Electrical Connectors
**c -** Fasteners

## Removal

1. Disconnect the electrical connectors at the ECM. Do NOT touch the connector pins.
2. Remove the ECM from the electrical bracket.

## Cleaning and Inspection

1. Clean the exterior of the ECM with a dry cloth, be careful to avoid contact with connector pins.
2. Inspect outer surfaces for any obvious damage.
3. Visually inspect electrical pins at both ends of ECM for straightness and corrosion.
4. Visually inspect the connectors on the wiring harness for corrosion and terminals that may have loose connections.

***NOTE:*** *The ECM is a sealed electrical component. If it is defective, replace the ECM.*

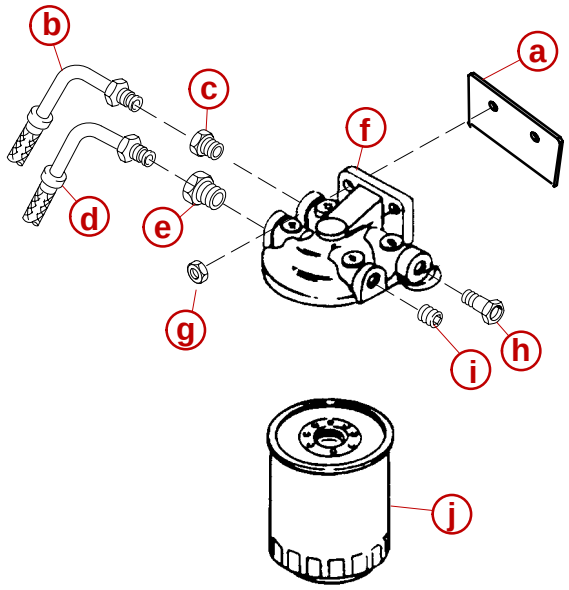
## Installation

1. Mount the ECM to electrical bracket using screws and washers.
2. Connect the electrical connectors to the ECM. Do NOT touch the connector pins.

# Water Separating Fuel Filter

**⚠ WARNING**

**The fuel injection system is pressurized. Avoid serious injury from an explosion. Use care when removing water separating fuel filter. Allow engine to cool down before removing the water separating fuel filter. Also, hold a clean shop towel over the water separating fuel filter when removing it, to help avoid fuel spraying on the engine.**




78131

**a** - Insulator Plate
**b** - Fuel Return Line from Regulator
**c** - Brass Fitting
**d** - Fuel Line to Fuel Pump
**e** - Brass Fitting
**f** - Fuel Filter Mounting Bracket
**g** - Nut
**h** - Fuel Inlet Fitting
**i** - Plug
**j** - Water Separating Fuel Filter

## Removal

**⚠ WARNING**

**Avoid injury or death and power package damage from an electrical shock, fire or explosion. Always disconnect both battery cables from the battery before servicing the power package.**

1. Disconnect both battery cables from the battery.
2. Activate the Schrader valve to relieve fuel pressure.
3. Remove the fuel filter from the base. A filter wrench may be needed.

## Installation

1. Lubricate sealing ring of new filter with engine oil.

| Description | Where Used | Part Number |
|---|---|---|
| Engine Oil | Sealing Ring | Obtain Locally |

2. Install a new filter. Tighten securely by hand.
3. Connect both battery cables to the battery.
4. Supply water to cooling system.
5. Start engine.
6. Check for fuel leaks.

# Cool Fuel System

## Removal

**⚠ WARNING**

**Avoid injury or death and power package damage from an electrical shock, fire or explosion. Always disconnect both battery cables from the battery before servicing the power package.**

1. Disconnect both battery cables from the battery.

**⚠ CAUTION**

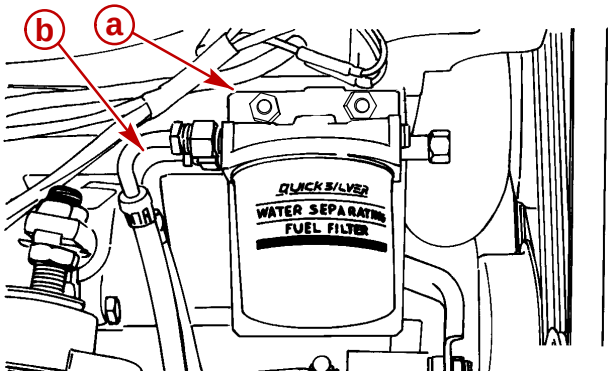
**If boat is to remain in the water, the seacock, if equipped, must remain closed until engine is to be restarted to prevent water from flowing back into seawater cooling system. If boat is not fitted with a seacock, water inlet hose must be disconnected and plugged to prevent water from flowing into cooling system and/or boat.**

2. Close the seacock, if equipped. If boat is not equipped with a seacock, remove and plug the seawater inlet hose.
3. Drain the seawater system. Refer to SECTION 1B.
4. Disconnect the seawater hoses from the fuel cooler.

**IMPORTANT: Plug open ends of fuel line connections to prevent fuel leaks and entry of water or contaminates into lines while working.**

5. Close fuel shut off valve, if equipped, and remove the fuel tank inlet line from the water separating fuel filter. If boat is not equipped with a fuel tank shut off valve, remove the fuel tank inlet line at the water separating fuel filter and plug the line.

6. Activate the Schrader valve to relieve fuel pressure.
7. Disconnect fuel lines from water separating fuel filter adapter.

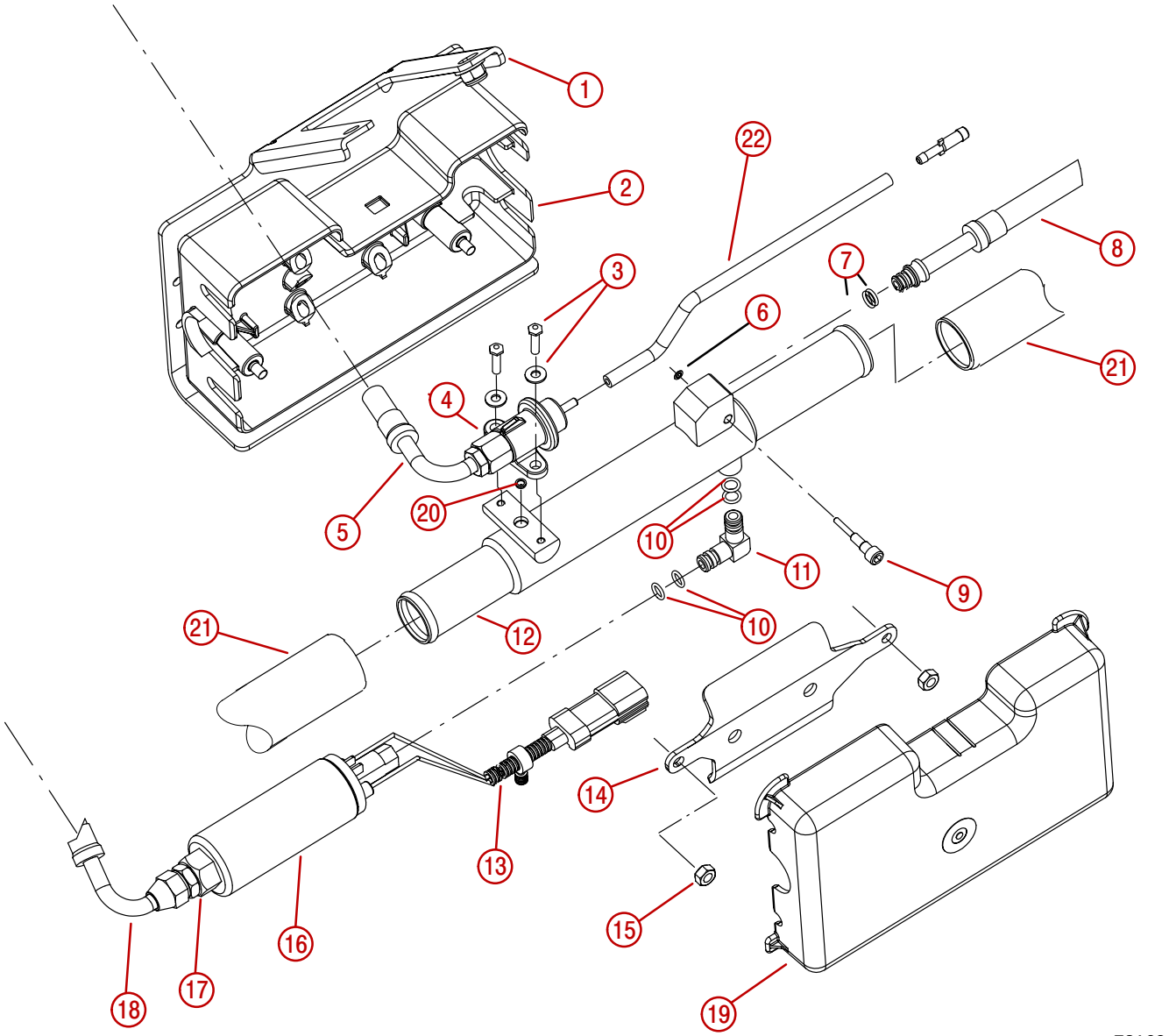



75533

**a** - Filter Adapter
**b** - Fuel Lines

8. Disconnect the fuel line from the rail.
9. Disconnect the fuel pump electrical connector.
10. Disconnect the vacuum hose between the pressure regulator and the intake manifold.
11. Remove the two fuel cooler bracket nuts from the engine mount bracket studs.
12. Carefully remove the cool fuel system assembly.

# Disassembly




78160

**1 -** Bracket
**2 -** Cover Base
**3 -** Screw And Washer (2)
**4 -** Fuel Pressure Regulator
**5 -** Return Fuel Line
**6 -** Retaining Ring
**7 -** O-rings (2)
**8 -** Fuel Line, Fuel Pump-To-Fuel Rail
**9 -** Stepped Screw
**10 -** O-rings (4)
**11 -** Elbow Fitting
**12 -** Fuel Cooler
**13 -** Fuel Pump Wiring Harness
**14 -** Retainer Bracket
**15 -** Nut (2)
**16 -** Electric Fuel Pump
**17 -** Inlet Fitting
**18 -** Fuel Line Inlet
**19 -** Cover
**20 -** Filter
**21 -** Seawater Hoses (Hose Clamps Not Shown)
**22 -** Vacuum Hose

***NOTE:*** *Retain all fasteners and hardware unless instructed otherwise.*

1. Remove the cool fuel system cover.
2. Remove the two nuts from the cool fuel retaining bracket studs.
3. Remove the retainer bracket.
4. Unclip the wiring harness from the cover base.
5. Remove the fuel cooler and the electric fuel pump assembly from the cover base.

**IMPORTANT: To prevent loss of the stepped screw used to secure the fuel cooler-to-fuel rail fuel line, a retainer ring is provided. Do not remove the retainer ring or stepped screw.**

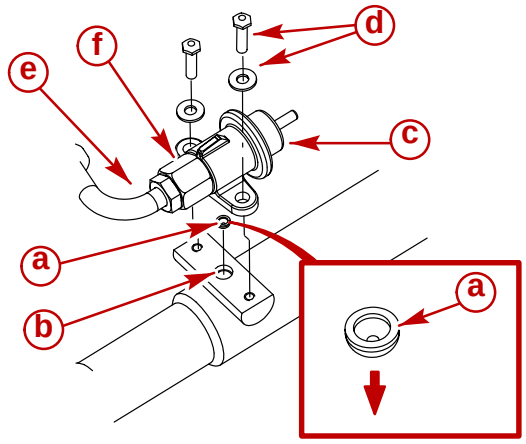
6. Loosen the stepped screw and remove the fuel line.
7. Hold the fuel line and fuel pump or fuel cooler fittings securely and remove the fuel lines.
8. Disconnect the elbow fitting and fuel pump from the fuel cooler assembly by pulling firmly.
9. Remove the elbow fitting from the fuel pump by pulling firmly.
10. Hold the fuel line and regulator fittings securely and remove the fuel line.
11. Remove the fuel line fitting from the fuel pressure regulator.
12. Remove the two screws and washers retaining the fuel pressure regulator to the fuel cooler.
13. Remove the regulator.
14. Remove the conical filter from the fuel cooler.
15. Disconnect the vacuum hose from the regulator by pulling firmly.

## Reassembly

1. Install the small filter (conical side DOWN) in the orifice of the new fuel cooler where the fuel pressure regulator mounts.
2. Install the regulator onto the cooler using the two screws with washers. Torque the screws.

| Description | Nm | lb-in. | lb-ft |
|---|---|---|---|
| Fuel Pressure Regulator Screws | 5.8 | 53 | |

3. Install the fitting into the regulator. Tighten securely.
4. Connect the fuel line to the regulator. Tighten securely.

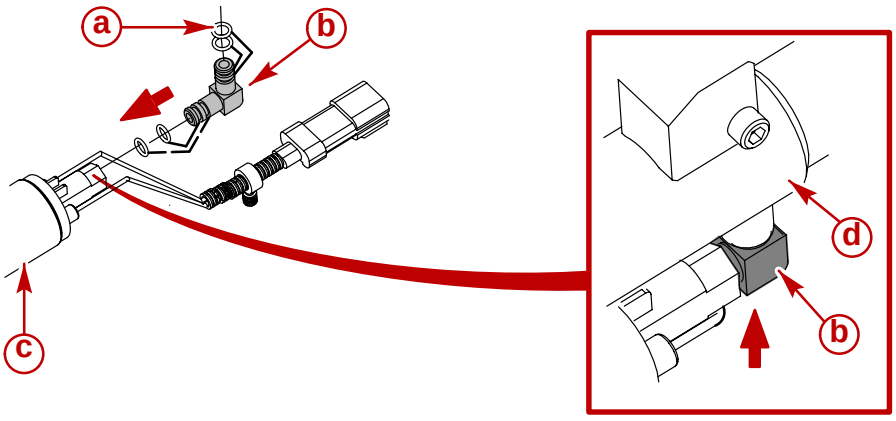



75708

**a** - Filter
**b** - Fuel Cooler Orifice
**c** - Fuel Pressure Regulator
**d** - Screw And Washer (2)
**e** - Fuel Line
**f** - Fitting

5. Install the vacuum hose onto the regulator.
6. Install the 4 O-rings on the fuel pump / cooler elbow fitting.
7. Lubricate O-rings for the elbow fitting with a small amount of liquid dish soap (obtain locally).

8. Install the elbow fitting in the fuel pump.
9. Install the fuel pump with elbow fitting in the cooler assembly.




75708

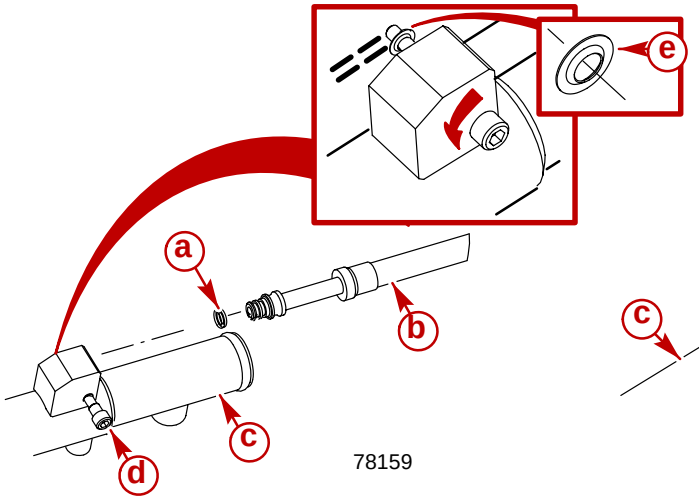
**a** - O-rings (4)
**b** - Elbow Fitting
**c** - Fuel Pump
**d** - Fuel Cooler

10. Install the fitting into the end of the fuel pump.
11. Install the fuel line for the water separating fuel filter to the fuel pump fitting.
12. Install fuel line seal onto the cooler-to-fuel rail fuel line where it attaches to the cooler.
13. Completely loosen, but do NOT remove, the stepped screw that retains the fuel line.
14. Lubricate the fuel line seal with a small amount of liquid dish soap (obtain locally).

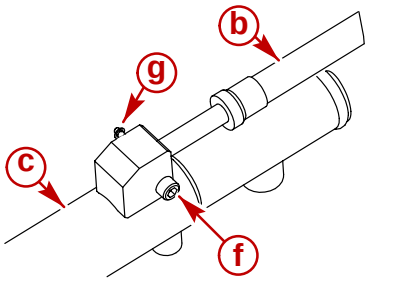
15. Insert the fuel line into the cooler orifice. Torque the stepped screw.

| Description | Nm | lb-in. | lb-ft |
|---|---|---|---|
| Stepped Screw | 9 | 81 | |

**IMPORTANT: To prevent loss of the stepped screw used to secure the cooler-to-fuel rail fuel line, a retainer ring is provided. Do not remove the retainer ring or stepped screw.**



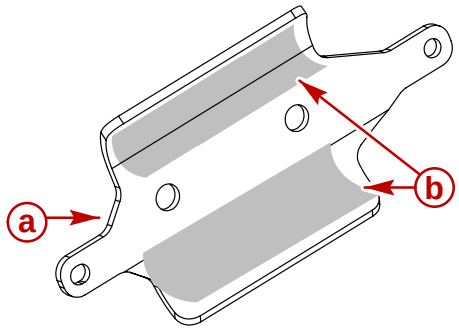

78159




75708

**a** - Fuel Line Seal
**b** - Fuel Line, Fuel Cooler-To-Fuel Rail
**c** - Fuel Cooler
**d** - Stepped Screw - Loosened To Accept Fuel Line
**e** - Retainer Ring
**f** - Stepped Screw - Torqued
**g** - Retainer Ring

16. Position the completed fuel cooler assembly in the cover base.
17. Apply a thin, even coating of Thermal Grease on all of the retainer bracket inside surfaces where it contacts the cooler and the fuel pump when installed.




**a -** Retainer Bracket
**b -** Thermal Grease

| Description | Where Used | Part Number |
|---|---|---|
| Thermal Grease | Cool Fuel Retainer Bracket | Obtain Locally |

18. Install the retainer bracket over the cooler and fuel pump. Apply sealant to the threads of the mounting studs.

| Description | Nm | lb-in. | lb-ft |
|---|---|---|---|
| Nuts, Retainer Bracket | 5.6 | 50 | |

| Description | Where Used | Part Number |
|---|---|---|
| Loctite 242 | Fuel Cooler Mounting Studs | 92-809821 |

## Installation

1. Place the cool fuel assembly on the engine mount studs. Install the two nuts.

| Description | Nm | lb-in. | lb-ft |
|---|---|---|---|
| Nuts, Engine Mount Studs | 41 | | 30 |

2. Connect the fuel lines to the fuel filter adapter and tighten securely.

| Description | Nm | lb-in. | lb-ft |
|---|---|---|---|
| Fuel Lines | 24 | | 19 |

3. Connect fuel line to the fuel rail.
4. Connect vacuum line to intake manifold.
5. Attach engine harness electrical connector to fuel pump harness connector.
6. Clip fuel pump harness to cool fuel base.

**⚠ CAUTION**

**Do NOT operate engine without cooling water being supplied to seawater pickup pump, or pump impeller will be damaged and subsequent overheating damage may result.**

7. Connect seawater hoses to cool fuel system. Tighten hose clamps securely.
8. Unplug and connect seawater inlet hose. Open seacock, if equipped.
9. Unplug and connect fuel tank inlet line. Tighten hose clamp securely. Open fuel shut off valve, if equipped.

**⚠ CAUTION**

**When installing battery, be sure to connect POSITIVE (+) battery cable to POSITIVE (+) battery terminal FIRST, and NEGATIVE (–) battery cable to NEGATIVE (–) battery terminal LAST. If battery cables are reversed, or connection order is reversed, electrical system damage will result.**

10. Clean battery cable clamps and terminals and connect battery cables to the battery. Secure each cable clamp when connecting. Coat terminals with a battery terminal anti-corrosion spray to help retard corrosion.
11. Start the engine; check for fuel and water leaks. Stop the engine immediately if any leaks exist. Make necessary corrections.
12. Install cool fuel system cover.

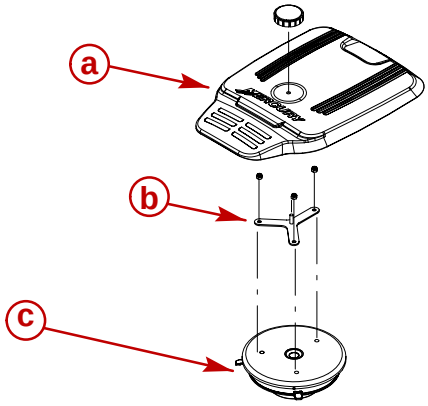
**⚠ WARNING**

**Ensure that no leaks exist before closing engine hatch.**

# Intake Manifold

## Removal

1. Remove the engine cover and the flame arrestor.




78268

**a** - Engine Cover
**b** - Retainer Bracket
**c** - Flame Arrestor

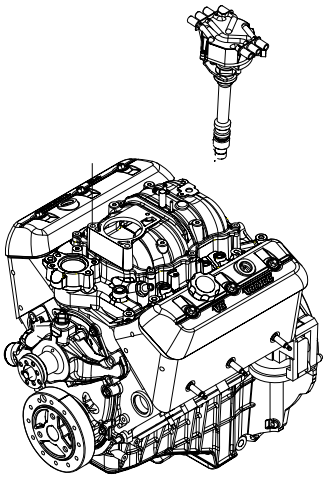
2. Drain the cooling system.
3. Remove the hoses from the thermostat housing.
4. Disconnect the throttle cable from the throttle cable bracket and throttle body.
5. Disconnect the fuel line from the fuel rail.

**⚠ WARNING**

**Avoid injury or death and power package damage from an electrical shock, fire or explosion. Always disconnect both battery cables from the battery before servicing the power package.**

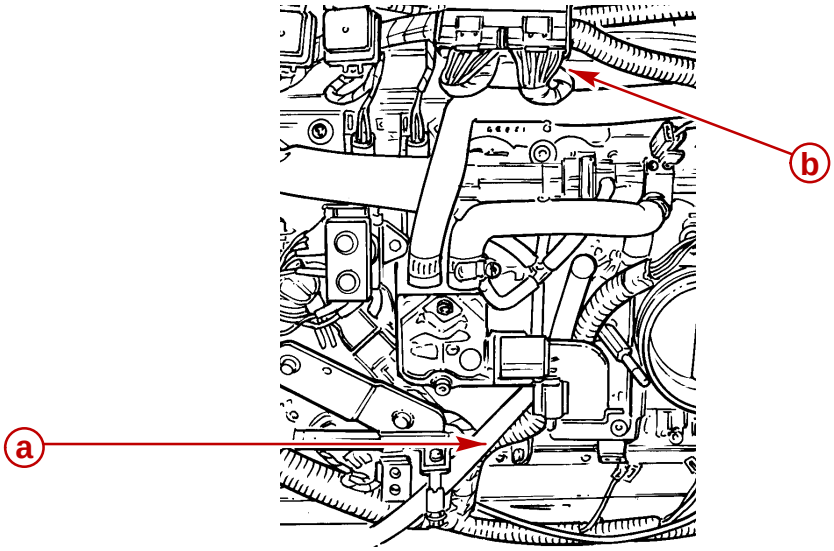
6. Disconnect both battery cables.

7. Remove the distributor.



78268

8. Disconnect the electrical harness from the fuel injectors.
9. Disconnect the vacuum hose from the starboard valve cover.




77906

**a** - Vacuum Hose
**b** - Fuel Injector Connection

10. Remove the valve covers.

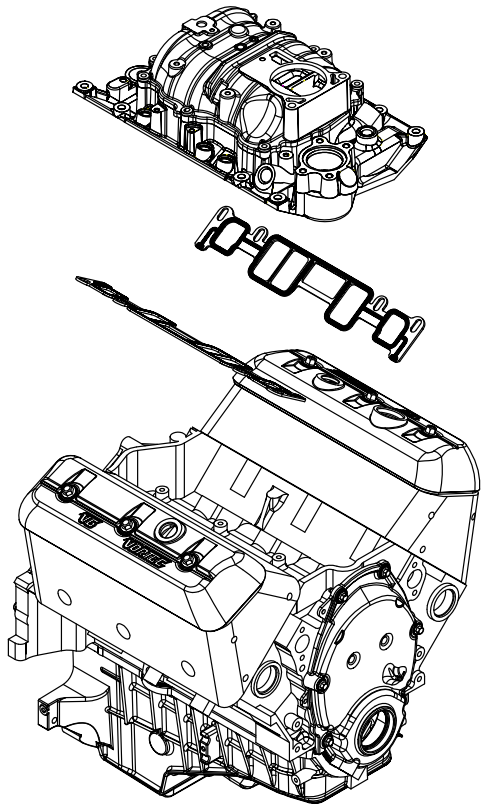
11. Remove the lower intake manifold bolts.

**IMPORTANT: The intake manifold may be removed as an assembly. Do not remove the specific intake manifold components unless component service is required.**

**⚠ CAUTION**

**Dirt or debris may enter the fuel system causing fuel system or engine failure. Seal the ends of the fuel system properly.**

12. Remove the intake manifold assembly.

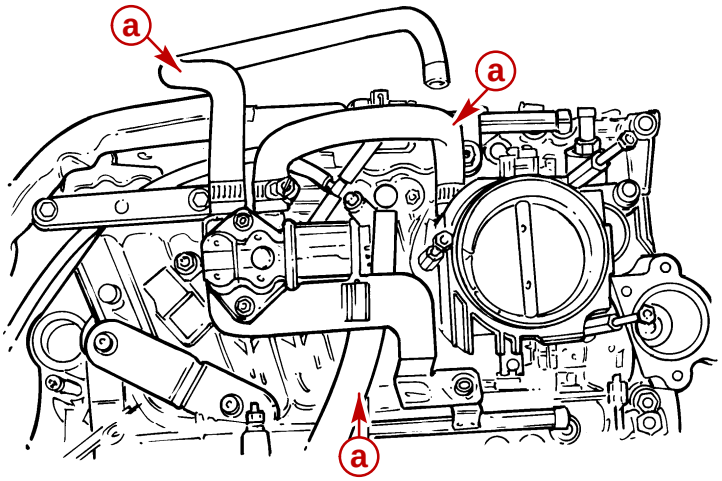


78262

13. Remove and discard the lower intake manifold gaskets.

# Disassembly

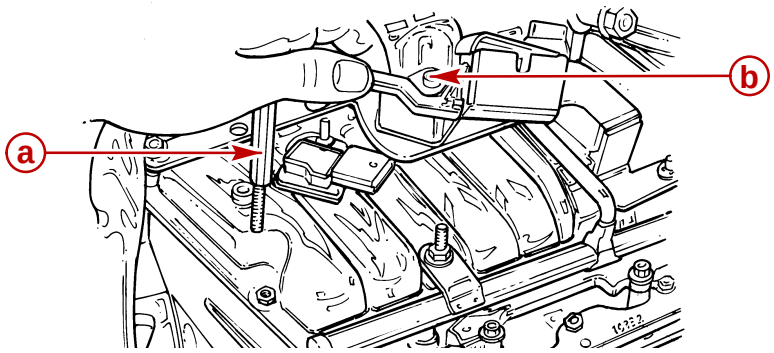
1. Remove all crankcase ventilation hoses.




77997

**a** - Hoses

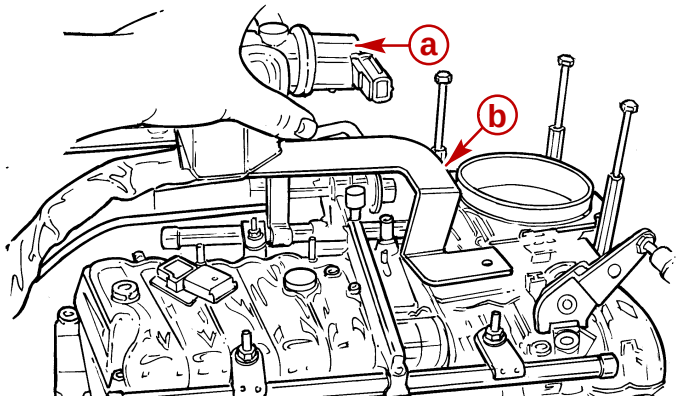
2. Remove the throttle cable bracket nuts. The stud at the rear of the intake manifold may loosen instead of the nut.




77998

**a** - Throttle Cable Stud
**b** - Throttle Cable Bracket

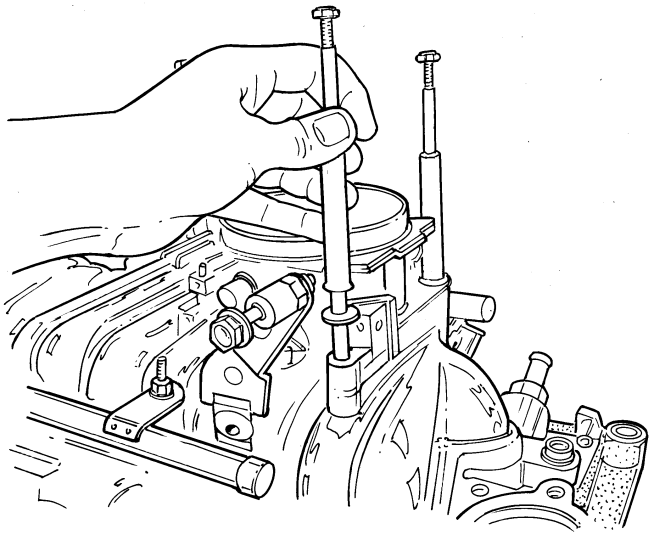
3. Remove the IAC bracket nuts.
4. Remove the IAC and bracket.




77999

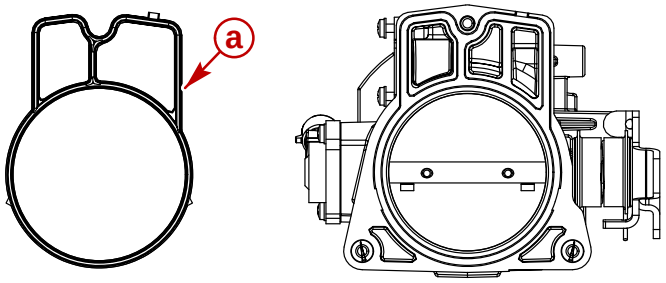
**a** - IAC
**b** - IAC Bracket

5. Remove the ignition coil.
6. Remove the throttle body attaching studs.



78161

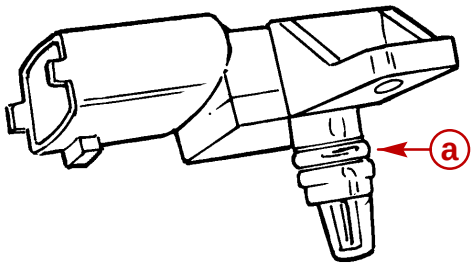
7. Remove the throttle body.
8. Remove and discard the throttle body sealing ring.




78158

**a** - Sealing Ring

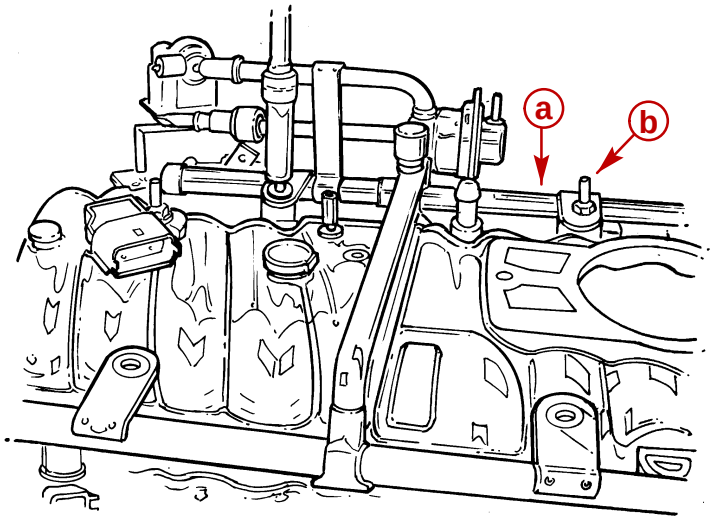
9. Remove the thermostat housing.
10. Remove the MAPT and discard the seal.




78083

**a** - Seal

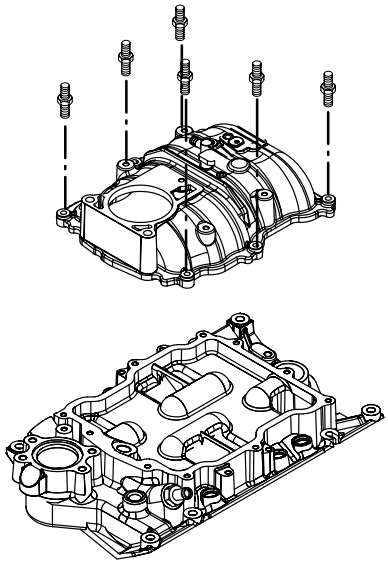
11. Remove the fuel rail studs.
12. Remove the fuel rail.




78082

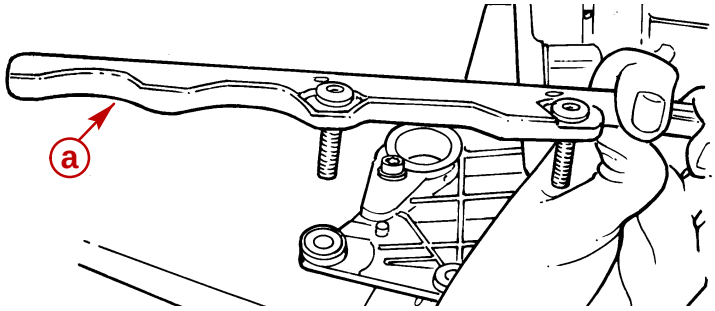
**a** - Fuel Rail
**b** - Fuel Rail Studs

13. Remove the upper intake manifold studs.
14. Remove the upper intake manifold.



78088

15. Remove and discard the upper intake manifold to lower intake manifold gasket.
16. Remove the brackets on both sides of the lower intake manifold.




78085

**a** - Bracket

## Cleaning and Inspection

1. Remove any gasket material from the intake manifold and cylinder head.
2. Clean the intake manifolds in cleaning solvent.
3. Dry the intake manifolds with compressed air.
4. Inspect the intake manifolds for cracks or damage to the exterior surfaces, the gasket grooves or the gasket sealing surfaces.
5. Inspect the cooling system passages for restriction.
6. Inspect the threads in the bolt holes for damage.

## Assembly

1. Install the brackets on both sides of the lower intake manifold.
2. Install the new upper intake manifold-to- lower intake manifold gasket into the groove of the upper intake manifold.
3. Install the upper intake manifold onto the lower intake manifold.
4. If reusing the fasteners, apply adhesive to the threads of the upper intake manifold attaching studs.

| Description | Where Used | Part Number |
|---|---|---|
| Loctite 242 | Throttle Body Fasteners | 92-809821 |

5. Install the upper intake manifold attaching studs.
6. Torque the upper intake manifold attaching studs.

| Description | | Nm | lb-in. | lb-ft |
|---|---|---|---|---|
| Studs, Upper Intake Manifold | | | | |
| | First Pass | 5 | 44 | |
| | Second Pass | 10 | 89 | |

7. Install the fuel rail and injectors on the intake manifold.
8. If reusing the fasteners, apply adhesive to the threads of the fuel rail bolt.

| Description | Where Used | Part Number |
|---|---|---|
| Loctite 242 | Throttle Body Fasteners | 92-809821 |

9. Install the fuel rail studs.
10. Torque the fuel rail nuts.

| Description | Nm | lb-in. | lb-ft |
|---|---|---|---|
| Nuts, Fuel Rail Retainer | 3 | 27 | |

11. Install a new MAPT sensor seal onto the MAPT sensor.
12. Apply 1 drop of clean engine oil to the MAPT sensor seal.
13. Install the MAPT sensor into the upper intake manifold.

| Description | Nm | lb-in. | lb-ft |
|---|---|---|---|
| MAPT Fasteners | 6 | 53 | |

14. Install the ignition coil and the studs.
15. Torque the ignition coil studs.

| Description | Nm | lb-in. | lb-ft |
|---|---|---|---|
| Studs, Ignition Coil | 12 | 106 | |

16. Install the thermostat housing using a new gasket.
17. Install a new throttle body sealing ring into the groove in the throttle body.
18. Align the dowels and install the throttle body onto the upper intake manifold.
19. If reusing the fasteners, apply adhesive to the threads of the throttle body attaching studs.

| Description | Where Used | Part Number |
|---|---|---|
| Loctite 242 | Throttle Body Fasteners | 92-809821 |

20. Install the throttle body attaching studs. Torque the studs.

| Description | Nm | lb-in. | lb-ft |
|---|---|---|---|
| Studs, Throttle Body | 9 | 80 | |

21. Install the IAC bracket. Torque the nuts.

| Description | Nm | lb-in. | lb-ft |
|---|---|---|---|
| Nuts, IAC Bracket | 15 | 132 | |

22. Install the throttle cable bracket. Torque the nuts.

***NOTE:*** *Ensure that the stud and nut are threading correctly.*

| Description | Nm | lb-in. | lb-ft |
|---|---|---|---|
| Nuts, Throttle Cable Bracket | 19 | 168 | |

## Installation

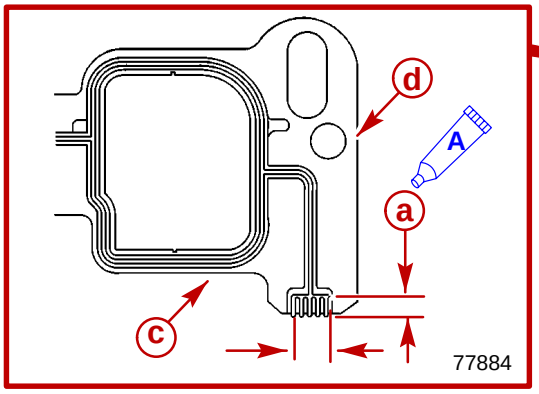
**⚠ CAUTION**

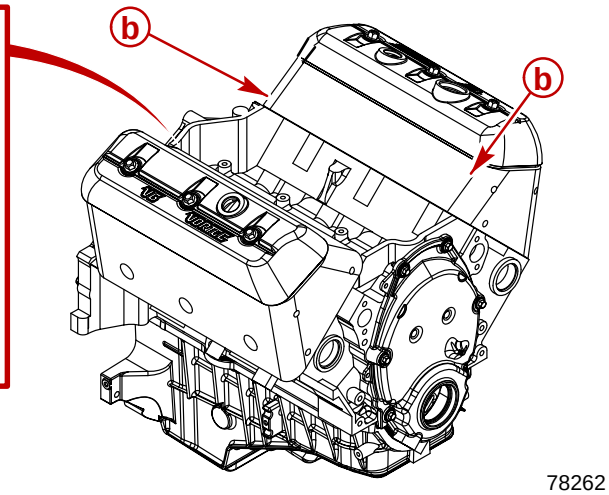
**Excessive amounts of adhesive or sealer on gaskets or component surfaces may cause improper sealing resulting in intake manifold air or fluid leaks. Do not apply excessive amounts of adhesive or sealer.**

1. Apply a 4 mm (5/32 in.) bead of adhesive at each end of the lower intake manifold gasket on the cylinder head side. Do NOT get sealer into oil sending unit hole.

***NOTE:*** *For proper adhesion, the lower intake manifold gasket must be installed while the adhesive is still wet.*

2. Align lower intake manifold gaskets with locator pins. Install lower intake manifold gaskets onto the cylinder heads.

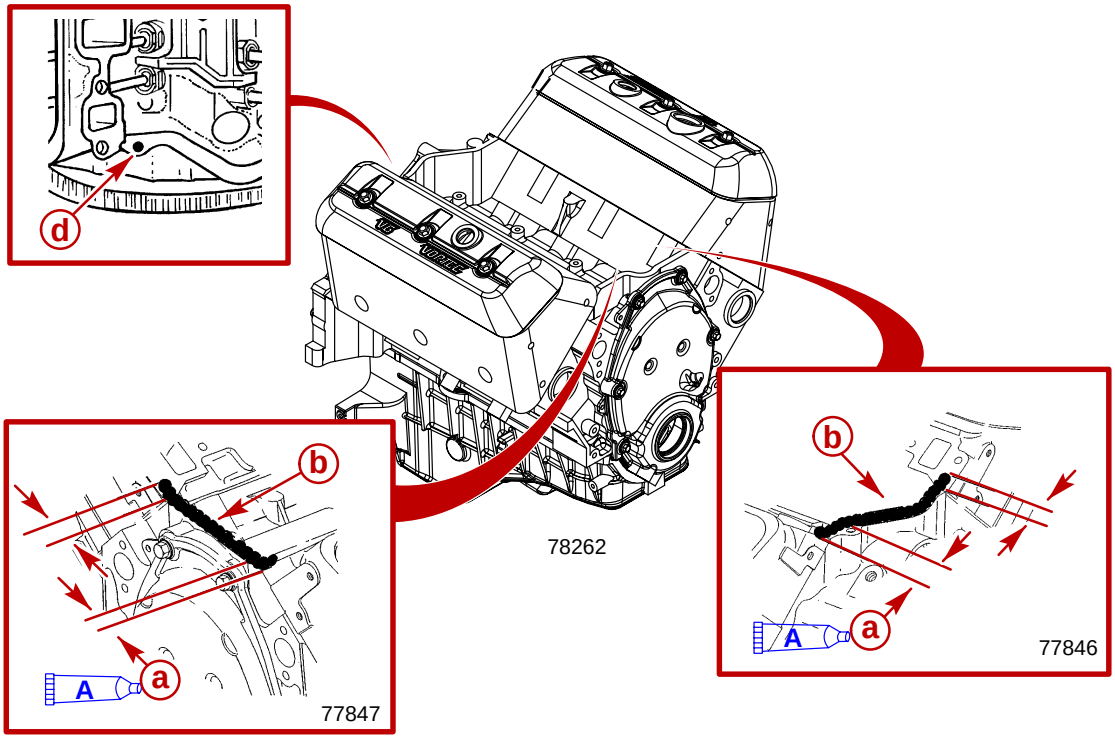



**a** - Area Of Adhesive
**b** - Locator Pin
**c** - Gasket
**d** - Locator Pin Hole

| Description | | Where Used | Part Number |
|---|---|---|---|
| A | Ultra-Black Loctite 5900 | Lower intake manifold gaskets | 92-809826 |

3. Apply a 5 mm (13/64 in.) wide bead of adhesive to front and rear of engine block as shown. Extend adhesive bead 13 mm (1/2 in.) up on intake gaskets; avoid blocking the hole.




**a** - Bead Of Adhesive
**b** - Front Top Of Engine Block
**c** - Rear Top Of Engine Block
**d** - Hole

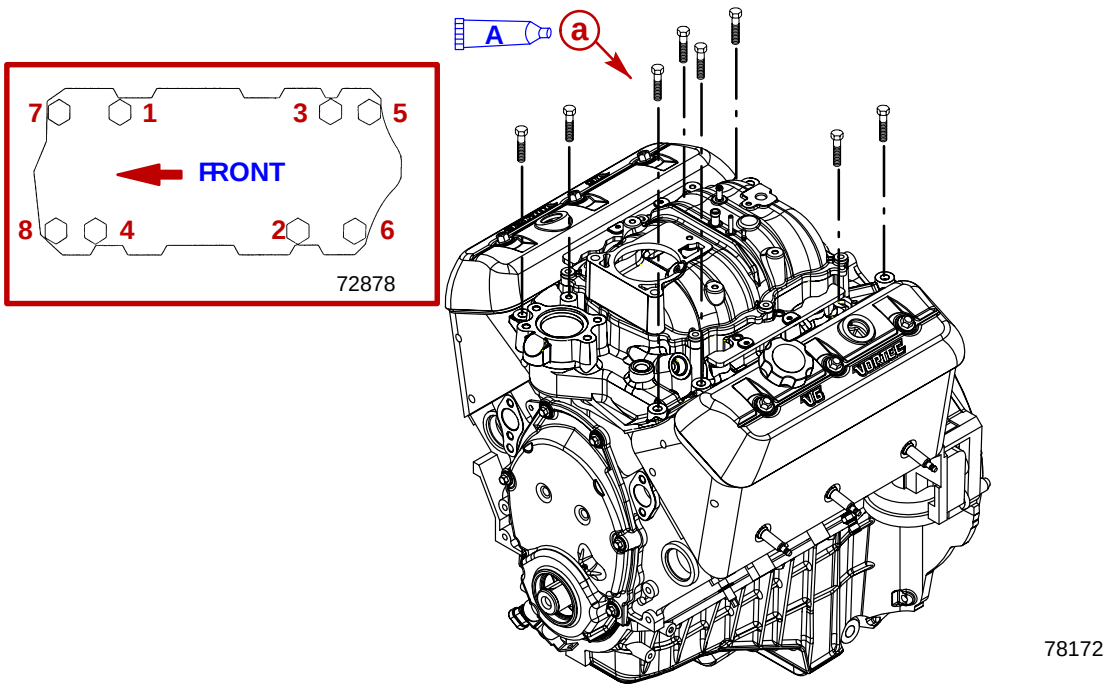
| Description | | Where Used | Part Number |
|---|---|---|---|
| A | Ultra-Black Loctite 5900 | Engine Block At The Lower Intake Manifold Sealing Surfaces | 92-809826 |

4. Coat threads of the lower intake manifold bolts with sealant.
5. Carefully install lower intake manifold, or intake manifold assembly, onto the engine block.

**⚠ CAUTION**

**Avoid engine damage. Crankshaft bearing bore alignment may become distorted resulting in damage to the crankshaft bearings if intake manifold fastener tightening sequence and torque are done improperly. Always torque the bolts in sequence to the specified amount in each of the three passes required.**

6. Torque lower intake manifold bolts in sequence and passes indicated.




**a** - Intake Manifold Bolts

| Description | | Where Used | Part Number |
|---|---|---|---|
| A | Loctite 242 | Lower Intake Manifold Bolt | 92-809821 |

| Description | | Nm | lb-in. | lb-ft |
|---|---|---|---|---|
| Lower Intake Manifold Bolt (Each Pass In Sequence) | | | | |
| | First Pass | 3 | 27 | |
| | Second Pass | 12 | 106 | |
| | Final Pass | 15 | 132 | |

7. Install the valve covers.
8. Connect all ignition and electrical leads.
9. Connect hoses to thermostat housing.
10. Install fuel line to fuel rail.
11. Connect crankcase ventilation hoses.
12. Install the distributor.

| Description | Nm | lb-in. | lb-ft |
|---|---|---|---|
| Distributor Hold Down Clamp Bolt | 25 | | 18 |

13. Install the ignition coil wire.
14. Install other ignition components and reconnect wires.
15. Connect any items that were disconnected.
16. Refill closed cooling system, if equipped.

**⚠ CAUTION**

**Overheating caused by insufficient cooling water will result in engine and drive system damage. Ensure that there is sufficient water always available at water inlet holes during operation.**

17. Provide cooling water to the engine.
18. Start engine.
19. Check hose connections, gaskets and seals for leaks.
20. Inspect fuel line connections for fuel leaks.
21. Install the flame arrestor.

| Description | Nm | lb-in. | lb-ft |
|---|---|---|---|
| Nut, Flame Arrestor Retainer Bracket | 12 | 108 | |

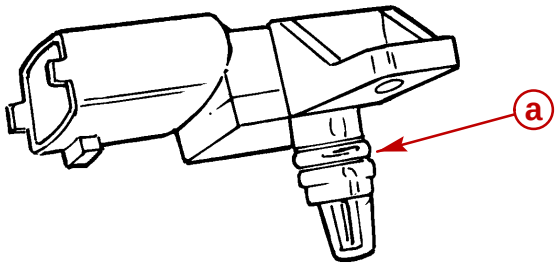
22. Install engine cover.

# Sensors

## Manifold Air Pressure / Temperature (MAPT) Sensor

### REMOVAL

1. Disconnect the wiring harness connection from the MAPT.
2. Remove the MAPT and discard the seal.




78083

**a -** Seal

### CLEANING AND INSPECTION

1. Clean the surfaces of the MAPT with a dry cloth.
2. Inspect the MAPT for signs of wear or damage.

### INSTALLATION

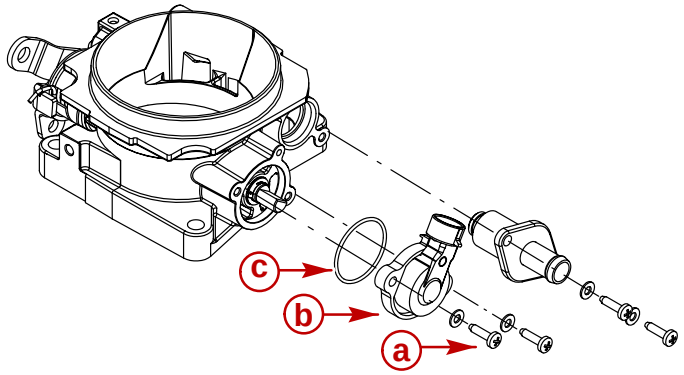
3. Install a new MAPT sensor seal onto the MAPT sensor.
4. Apply 1 drop of clean engine oil to the MAPT sensor seal.
5. Install the MAPT sensor into the upper intake manifold.

| Description | Nm | lb-in. | lb-ft |
|---|---|---|---|
| MAPT Fasteners | 6 | 53 | |

6. Connect electrical connector to the MAPT.

# Throttle Position Sensor (TPS)

1. Remove the engine cover and flame arrestor.
2. Disconnect the harness connector from the TPS.
3. Remove the screws from the TPS.
4. Remove the TPS from the throttle body.




78124

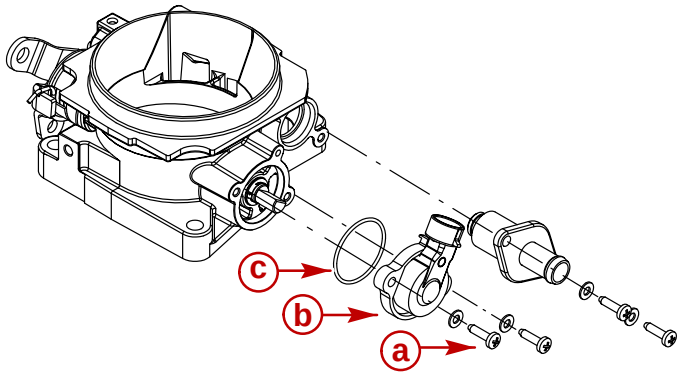
**a** - Screw (2)
**b** - Throttle Position Sensor
**c** - O-ring

## CLEANING AND INSPECTION

1. Clean the surfaces of the TPS with a dry cloth.
2. Inspect the TPS for signs of wear or damage.

## INSTALLATION

1. Apply adhesive to screw threads. Install the TPS on the intake manifold. Torque screws.




78124

**a** - Screw (2)
**b** - Throttle Position Sensor
**c** - O-ring

| Description | Where Used | Part Number |
|---|---|---|
| Loctite 242 | TPS Screws | 92-809821 |

| Description | Nm | lb-in. | lb-ft |
|---|---|---|---|
| Throttle Position Sensor (TPS) | 2 | 20 | |

2. Place a new sealing ring in the groove.
3. Install throttle body on the intake manifold. Torque nuts.

| Description | Nm | lb-in. | lb-ft |
|---|---|---|---|
| Nuts, Throttle Body | 10 | 88 | |

4. Connect electrical connector to the TPS.
5. Install the flame arrestor.

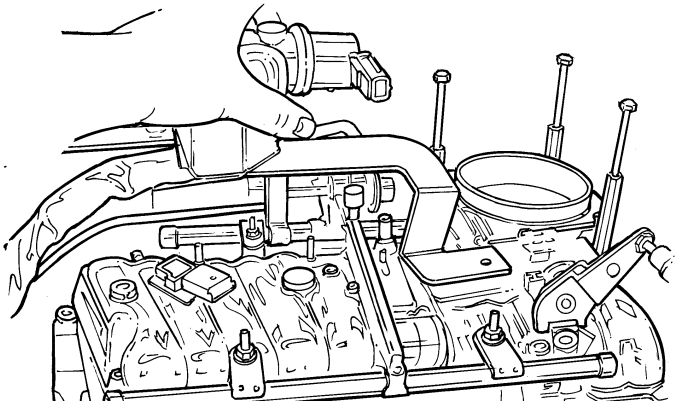
| Description | Nm | lb-in. | lb-ft |
|---|---|---|---|
| Nut, Flame Arrestor Retainer Bracket | 12 | 108 | |

6. Install the engine cover.
7. When negative (–) battery cable has been reconnected, start engine and check for TPS output voltage. It should be approximately 0.7 volts at idle and 4.5 volts at wide open throttle.

# Idle Air Control (IAC) Valve

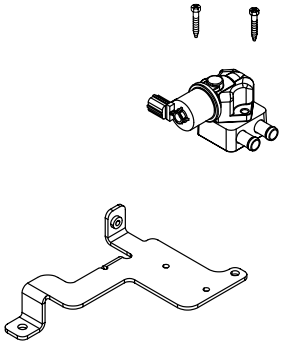
## REMOVAL

1. Remove the engine cover.
2. Remove the IAC hoses.
3. Disconnect the electrical connector.
4. Remove the IAC bracket nuts.
5. Remove the IAC and bracket.



77999

6. Remove the 2 screws retaining the IAC to the bracket.



78088

## CLEANING AND INSPECTION

1. Clean the external surfaces with a dry cloth.
2. Inspect surfaces for signs of wear or physical damage.

## INSTALLATION

1. Install IAC valve and bracket onto intake. Torque fasteners.

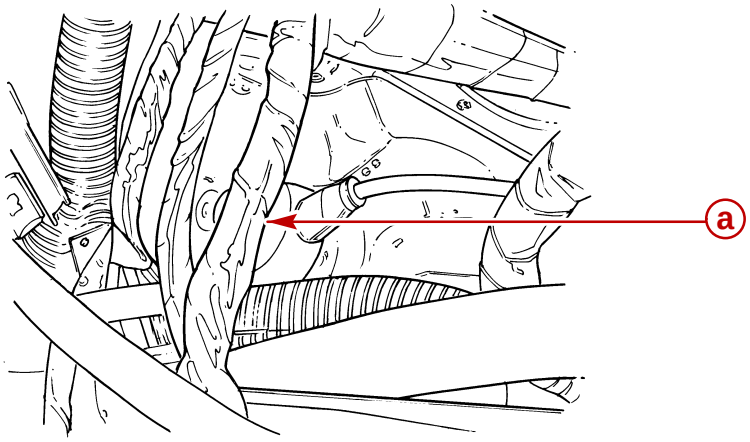
| Description | Nm | lb-in. | lb-ft |
|---|---|---|---|
| Bolts, IAC to Bracket | 19 | 168 | |
| Nuts, IAC Bracket | 15 | 132 | |

2. Connect electrical connector to IAC.

# Knock Sensor

## REMOVAL

1. Remove the bolt retaining the knock sensor on the rear of the engine.




78192

2. Remove the knock sensor from engine block.

## CLEANING AND INSPECTION

1. Clean knock sensor with a dry cloth, paying special attention to threads on base.
2. Inspect surfaces of knock sensor for signs of wear or physical damage.

## INSTALLATION

**IMPORTANT: If installing a new knock sensor, be sure to replace it with an identical part. Knock sensors are very sensitive and designed for each specific application.**

**IMPORTANT: In the following step, it is very important that the knock sensor be torqued to the precise specification. Incorrect torquing will result in unsatisfactory performance. Do NOT use sealer on threads.**

1. Install knock sensor in engine block. Torque nut.

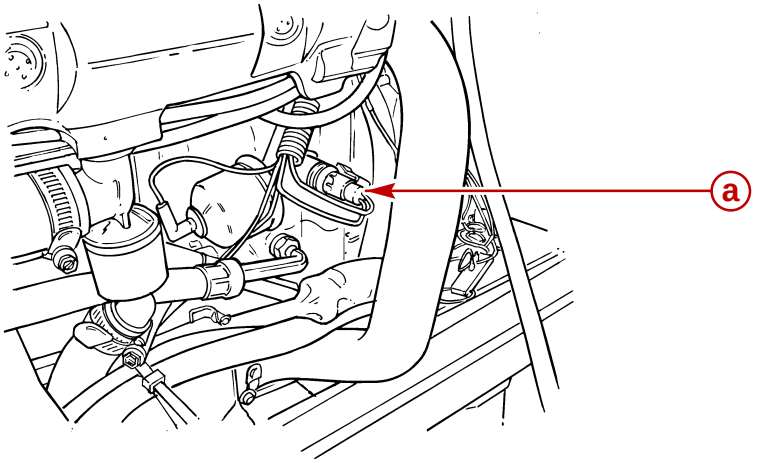
| Description | Nm | lb-in. | lb-ft |
|---|---|---|---|
| Nut, Knock Sensor | 20 | | 15 |

2. Connect electrical connector to knock sensor.

# Oil Pressure Sensor

## REMOVAL

1. Disconnect the electrical connector.




78192

2. Remove the oil pressure sensor from the engine block.

## CLEANING AND INSPECTION

1. Clean the external surfaces with a dry cloth.
2. Inspect surfaces for signs of wear or physical damage.

## INSTALLATION

1. Install the sensor into the engine block.

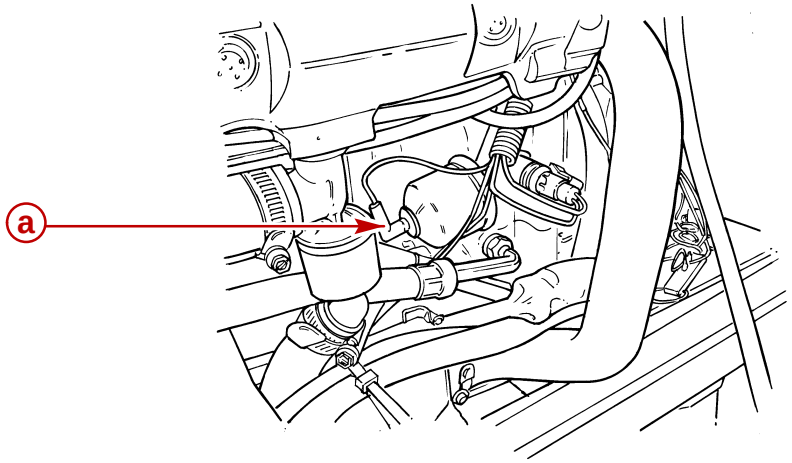
| Description | Nm | lb-in. | lb-ft |
|---|---|---|---|
| Oil Pressure Sensor | 20 | | 15 |

2. Connect the electrical connector.

# Oil Pressure Switch

## REMOVAL

1. Disconnect the electrical connector.




78192

2. Remove the oil pressure sensor from the engine block.

## CLEANING AND INSPECTION

1. Clean the external surfaces with a dry cloth.
2. Inspect surfaces for signs of wear or physical damage.

## INSTALLATION

1. Install the sensor into the engine block.

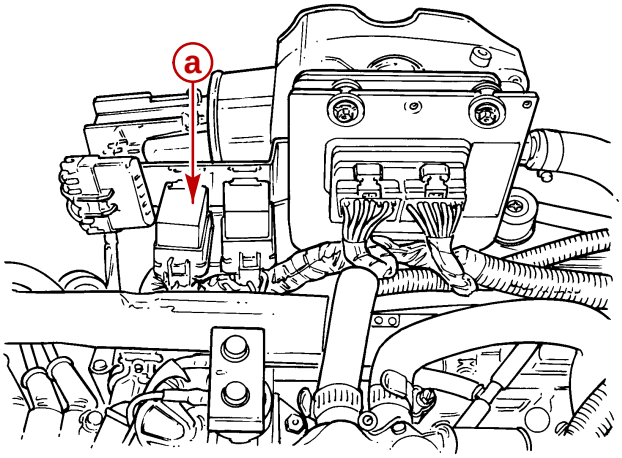
| Description | Nm | lb-in. | lb-ft |
|---|---|---|---|
| Oil Pressure Switch | 20 | | 15 |

2. Connect the electrical connector.

# Fuel Pump Relay

## REMOVAL

1. Remove the fuel pump relay from the electrical bracket.




77905

**a -** Fuel Pump Relay

2. Disconnect the electrical connector and remove the fuel pump relay.

## CLEANING AND INSPECTION

1. Clean the external surfaces with a dry cloth.
2. Inspect surfaces for signs of wear or physical damage.

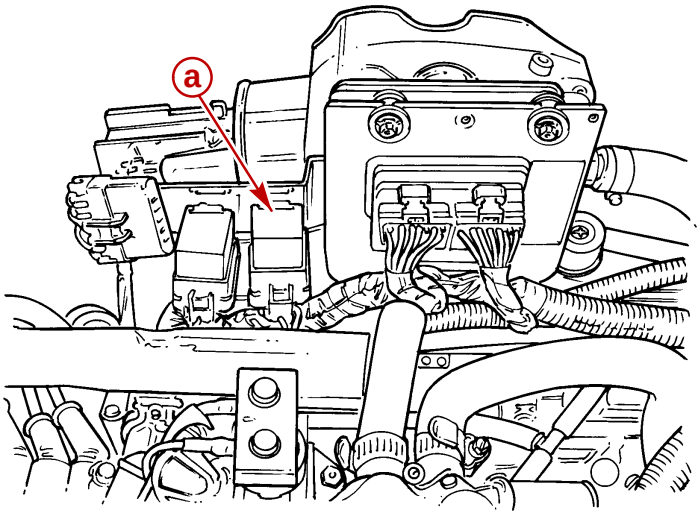
## INSTALLATION

1. Connect the electrical connector to the relay.
2. Attach the fuel pump relay to the electrical bracket.

# Main Power Relay

## REMOVAL

1. Remove the main power relay from the electrical bracket.




77905

**a -** Main Power Relay

2. Disconnect the electrical connector and remove the relay.

## CLEANING AND INSPECTION

1. Clean the external surfaces with a dry cloth.
2. Inspect surfaces for evidence of damage.

## INSTALLATION

1. Attach the electrical connector to the relay.
2. Attach the main power relay to the electrical bracket.

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# COOLING SYSTEM

## Section 6A - All Models

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| Seawater Inlet Recommendations | 6A-3 | Removal | 6A-14 |
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6 A

# Torque Specifications

***NOTE:*** *Securely tighten all fasteners not listed below.*

| Description | Nm | lb-in. | lb-ft |
|---|---|---|---|
| Nut, Seawater Pickup | 48 | | 35 |
| Bolt, Seawater Pump | 9.9 | 88 | |
| Fastener, Water Pump | 48 | | 35 |
| Fasteners, Water Distribution Housing Bracket | 38 | | 28 |
| Screws, Water Distribution Housing-To-Bracket | 13.5 | 120 | |

# Lubricants / Sealants / Adhesives

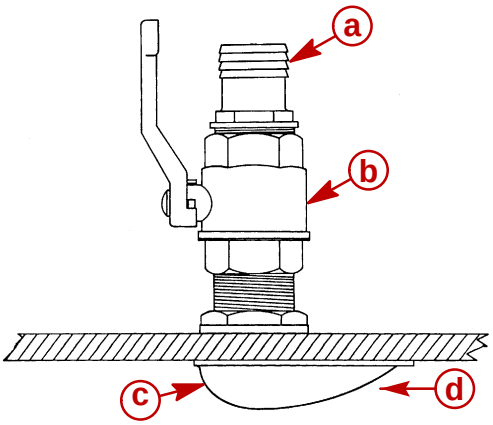
| Description | Where Used | Part Number |
|---|---|---|
| Loctite 271 | Seawater pickup fasteners | 92-809819 |
| Marine Caulk | Boat hull and seawater pickup joints | Obtain Locally |
| Loctite 567 PST Pipe Sealant | Transom mounted seawater pickup fitting and plastic plug | 92-809822 |
| Silicone Sealant Or Equivalent | Transom mounted seawater pickup screws | Obtain Locally |
| Engine Oil | Seawater pump bearing shaft | Obtain Locally |
| Loctite 609 | Seawater pump retainer/seal | Obtain Locally |
| Quicksilver Perfect Seal | Water circulating pump gaskets and fasteners | 92-34227-1 |

# Seawater Inlet Recommendations

## Seacock (Seawater Inlet Valve)

The seacock used must have an internal cross-sectional area equal to or greater than seawater inlet hose to prevent restricting water flow. Install valve in an area where it will be easily accessible and supported adequately to prevent hose fatigue. A brass ball or gate valve is required. Select a proper seacock based on the following chart:

| Seacock Size (Internal Cross-Sectional Area Equal to or Greater Than Size Shown) | |
|---|---|
| Gasoline Engines | 1-1/4 in. (32 mm) |




70355

**Seacock**

- **a** - Hose Connector 32 mm (1-1/4 in.) I.D. To Seawater Pump Inlet
- **b** - Seacock 32 mm (1-1/4 in.) Brass Ball Or Gate Valve
- **c** - Through-The Hull Seawater Pickup
- **d** - Direction Of Seawater Flow

## Seawater Strainer

Strainer used must be of sufficient size to ensure that an adequate supply of water will be maintained for cooling the engine. Select a proper seawater strainer based on the following chart:

| Seawater Strainer Minimum Flow Rate [1] | |
|---|---|
| Gasoline Engines | 114 (30) |

[1] *Amounts listed are in liters per minute and (gallons per minute).*

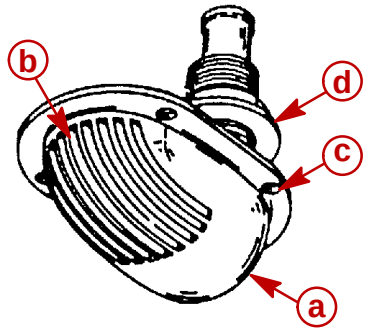
Install seawater strainer in an area where it will be easily accessible for inspection and cleaning. Strainer should be installed in water inlet hose after the seacock (water inlet valve) to allow operator to shut off water when cleaning strainer.

# Seawater Pickups

| NOTICE |
| --- |
| **Refer to the manufacturer's instructions for information on removal and installation of other than Quicksilver Seawater Pickups.** |

**IMPORTANT: Seal the inside edges of any hole made through the hull with a suitable sealant to prevent water absorption and deterioration.**

## Through the Hull Mounted




72639

**a** - Seawater Pickup
**b** - Seawater Inlet Slots
**c** - Mounting Screw Holes
**d** - Nut

1. Seal the inside edges of the 44 mm (1-3/4 in.) hole in the hull using a suitable sealer.
2. Apply marine caulking (sealer) to the mounting surface on the seawater pickup where the hull contact will occur when installed.

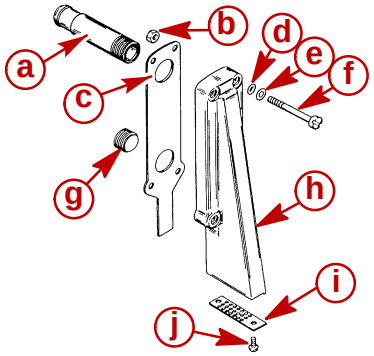
**IMPORTANT: The seawater inlet slots must face forward - parallel with the flow of water.**

3. Ensure that the slots in the seawater pickup are facing forward (toward the bow of the boat) and install the seawater pickup through the hull.
4. Fasten the pickup with mounting screws.
5. Apply sealant as needed inside the boat. Apply adhesive to the threads of the nut.
6. Install on the pickup and torque.
7. Ensure that the seawater inlet holes face forward.

| Description | Where Used | Part Number |
|---|---|---|
| Loctite 271 | Seawater pickup fasteners | 92-809819 |
| Marine Caulk | Boat hull and seawater pickup joints | Obtain Locally |

| Description | Nm | lb-in. | lb-ft |
|---|---|---|---|
| Nut, Seawater Pickup | 48 | | 35 |

# Transom Mounted




72640

**a** - Hose Fitting
**b** - Nut (4)
**c** - Gasket - Pickup-To-Transom
**d** - O-Ring (4)
**e** - Washer (4)
**f** - Screw (4)
**g** - Plastic Plug
**h** - Pickup
**i** - Screen
**j** - Screw (2)

1. Seal the inside edges of the 38 mm (1-1/2 in.) hole hose fitting and the plastic plug.

| Description | Where Used | Part Number |
|---|---|---|
| Loctite 567 PST Pipe Sealant | Transom mounted seawater pickup fitting and plastic plug | 92-809822 |

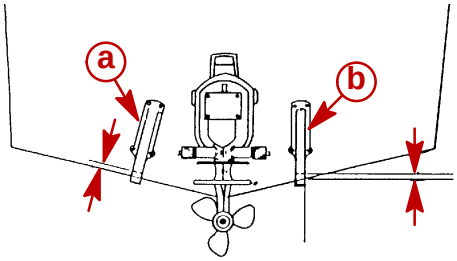
***NOTE:*** *Use a sharp knife or wood chisel to remove excess plastic plug material so that the plug is flush with the pickup casting.*

2. Position one flat washer and one rubber O-ring on each 5/16 in. x 4 in. (102 mm) long, round head screw. Coat each screw shaft with sealant.

| Description | Where Used | Part Number |
|---|---|---|
| Silicone Sealant Or Equivalent | Transom mounted seawater pickup screws | Obtain Locally |

3. Place the new gasket on the pickup housing and hold the pickup in place on the transom. Install four round head screws (with washers and O-rings in place) into the pickup mounting holes and through the drilled 8 mm (21/64 in.) holes in the transom.

***NOTE:*** *Some installations may have 5 mm (7/32 in.) holes drilled in the transom using four 5/16 in. diameter stainless steel lag bolts in place of round head screws. Flat washers and O-rings are always required.*




72641

**Water Pickup Installed on Transom**

**a -** Diagonal Mount - Leading Edge Of Pickup 3.2 mm (1/8 in.) From Boat Bottom
**b -** Vertical Mount - Corner Of Leading Edge Of Pickup 3.2 mm (1/8 in.) From Boat Bottom

4. Secure the water pickup from the inside with the locknuts and washers (unless using lag bolts).
5. Tighten the fasteners securely.

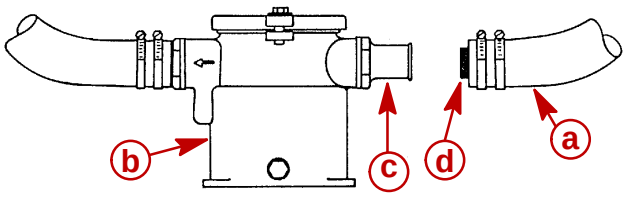
# Quicksilver Sea Strainer

| NOTICE |
| --- |
| **Refer to the manufacturer's instructions for information on other than Quicksilver Sea Strainer.** |

## Removal

| ⚠ CAUTION |
| --- |
| **If the boat is in the water while working on the seawater strainer, close the seacock, if equipped. If the boat is not equipped with a seacock, remove and plug the seawater inlet hose to prevent a siphoning action that may occur, allowing the seawater to flow from the drain holes or removed hoses and enter the boat.** |

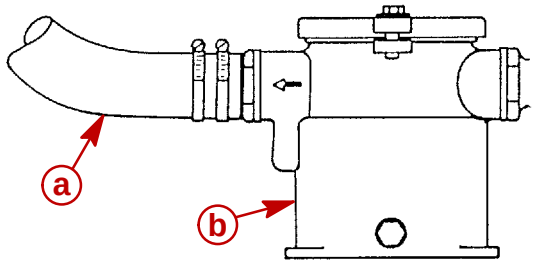
1. **Models Equipped with Seacock:**
   a. Close the seacock (water inlet valve).
   b. Disconnect the seawater inlet hose from the seawater strainer.
2. **Models without Seacock:**
   a. Disconnect the seawater inlet hose from the seawater strainer inlet and plug the seawater inlet hose.




70062

**a** - Seawater Inlet Hose
**b** - Seawater Strainer
**c** - Seawater Strainer Inlet
**d** - Plug

3. Remove the outlet hose. Drain into a suitable container.



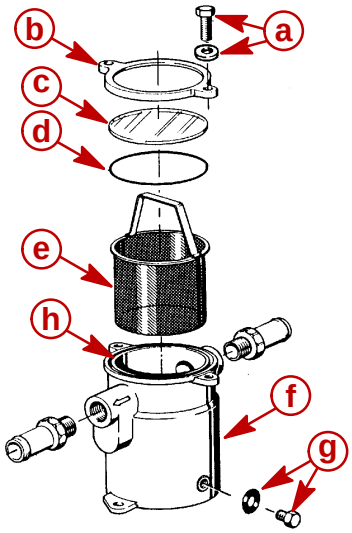

72643

**a** - Seawater Inlet Hose
**b** - Seawater Strainer

4. Remove the mounting bolts. Remove the strainer.

## Cleaning and Inspection

1. Remove and clean the filter element.
2. Remove the drain plug.




72673

**Quicksilver Seawater Strainer Shown**

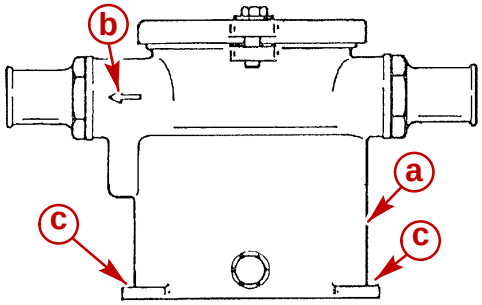
- **a** - Screws And Washers
- **b** - Cover
- **c** - Glass
- **d** - O-Ring
- **e** - Strainer
- **f** - Housing
- **g** - Drain Plug And Sealing Washer
- **h** - Gasket

3. Flush the components with clean water.

# Installation

**IMPORTANT: Mount the seawater strainer in a vibration-free location. Never mount it on the engine or the transmission. Hoses must not be kinked or allowed to come in contact with hot or moving engine or transmission parts.**

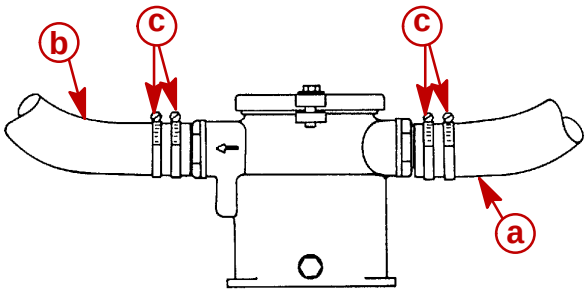
1. Mount the seawater strainer. The arrow indicates the required water flow direction and must point toward the seawater pump. Tighten the mounting bolts securely.




72644

**a** - Seawater Strainer
**b** - Arrow
**c** - Mounting Bolt Hole Location (Bolts Not Shown)

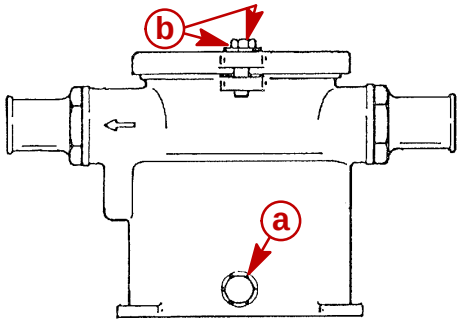
2. Remove the plug from the seawater inlet hose (if installed previously) and install the hose on the strainer. Install the seawater outlet hose. Use two hose clamps on each hose connection. Tighten the clamps securely.




72645

**a** - Seawater Inlet Hose
**b** - Seawater Outlet Hose
**c** - Double Hose Clamps

3. Check the drain plug and the lens cover bolts. Tighten securely. Do not overtighten the cover bolts or the cover may warp and leak water into the boat.




72644

**a** - Drain Plug
**b** - Lens Cover Bolts (2, One Not Shown In This View)

4. Open the seacock, if equipped.

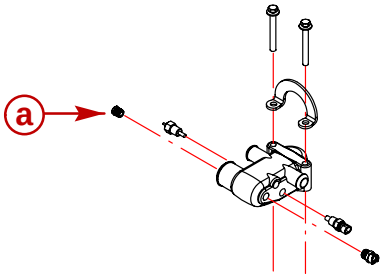
# Auxiliary Hot Water Heater Installation

**IMPORTANT: When connecting a cabin heater or a hot water heater, certain requirements must be met:**

- **The supply hose (from the engine to the heater) and the return hose (from the heater to the engine) MUST NOT EXCEED 16 mm (5/8 in.) I.D. (inside diameter).**
- **Make the heater connections ONLY at the locations described in the following instructions.**
- **Check the complete system for leaks after the heater is connected into the cooling system.**
- **Check for overheating condition (of the engine) after the heater is connected.**

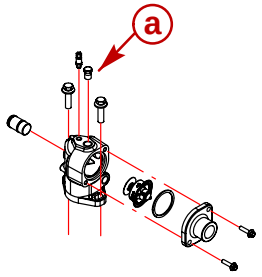
## Supply Hose Connection

***NOTE:*** *Some models may be equipped with additional fittings.*



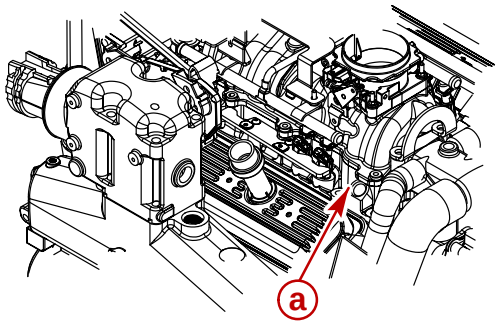

77816

**Seawater Cooled Models**




77815

**Closed Cooled Models**

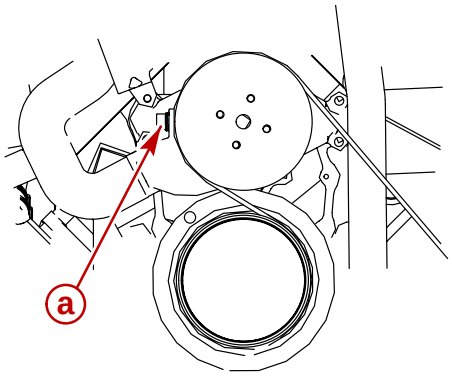



77933

**All Models**

**a -** Location For Hot Water Supply

## Return Hose Connection




77954

**a -** Location For Hot Water Return

# Seawater Pump

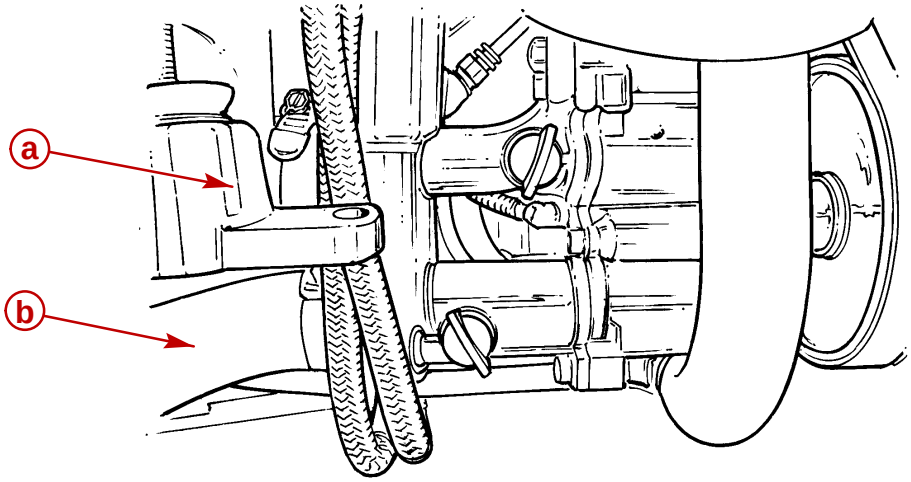
## Output Test

If an overheating problem exists, use this test to determine if a sufficient amount of water is being supplied to cool the engine.

**IMPORTANT: The following information should be observed before proceeding with the test:**

- **THE BOAT MUST BE IN THE WATER FOR THIS TEST. This test CANNOT BE performed with a flush-test device and water hose.**
- **The ability of this test to detect a problem is greatly dependent upon the accuracy with which it is performed. An error in setting the engine rpm, timing the test or measuring the water output will affect the overall accuracy of the test and may produce misleading results. To help ensure accurate results, a shop tachometer with an error of less than 5 percent should be used. The boat tachometer definitely should not be used as its accuracy is questionable. A stop watch should be used to time the duration of the test to help ensure that the accuracy is maintained within one second. An 7.6 Liter (8 U.S. qt.) or larger capacity container should be used to measure the water output.**
- **Due to the manner in which this test is performed, it may not be possible to detect a marginal condition or a high-speed water pump output problem.**

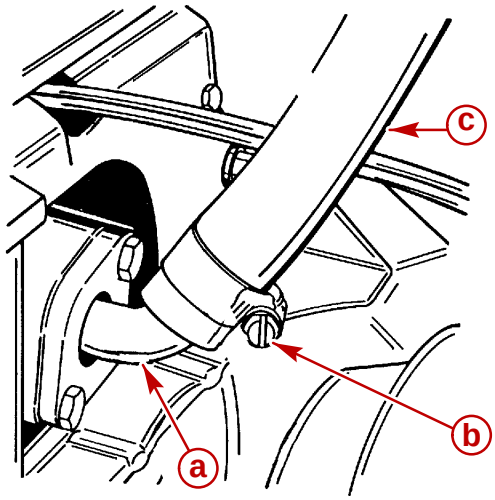
1. **Models With Engine Mounted Seawater Pump -** remove the water hose that is between the pump outlet and the engine, and replace with another hose of the same diameter, but approximately 1 m (3 ft.) longer. The hose should be of adequate wall thickness to prevent it from kinking when performing the test. Clamp the hose at the pump outlet only. Do not clamp the hose at the cooler end.




77908

**a -** Seawater Inlet Hose
**b -** Seawater Outlet Hose To Cooler

2. **Models With Sterndrive (Alpha) Mounted Seawater Pump -** remove the water inlet hose, which is between the gimbal housing water tube and the engine, and replace with another hose of the same diameter, but approximately 1 m (3 ft.) longer. The hose should be of adequate wall thickness to prevent it from kinking when performing the test. Clamp the hose at the gimbal housing water tube only. Do not clamp the hose at the engine end.




72614

**a -** Water Tube
**b -** Hose Clamp
**c -** Water Hose

3. Place an 7.6 Liter (8 U.S. qt.) or larger container near the unclamped end of the hose.
4. With the assistance of another person, start the engine and adjust the speed to exactly 1000 rpm while holding the unclamped end of the hose on the connection on the engine. Remove the hose from the connection on the engine and direct the water flow into the container for exactly 15 seconds. At the end of 15 seconds, direct the water flow overboard, return the engine to idle and stop the engine. Reconnect the hose to the engine.
5. Measure the quantity of water discharged into the container and compare with the specifications given in the following chart.
6. Repeat the test four times to check the repeatability of the results.

| Engine Mounted Seawater Pump Output For A 15 Second Period |
|---|
| 7.1 Liter (7.5 U.S. Qt.) Minimum |

| Alpha Sterndrive Seawater Pump Output For A 15 Second Period | |
|---|---|
| **Drive Unit Gear Ratio** | **Minimum Quantity Liter (U.S. Qts.)** |
| 1.98:1 | 2.8 (3.0) |
| 1.84:1 | 3.1 (3.3) |
| 1.65:1 | 3.4 (3.6) |
| 1.50:1 | 3.8 (4.0) |
| 1.32:1 | 4.3 (4.5) |

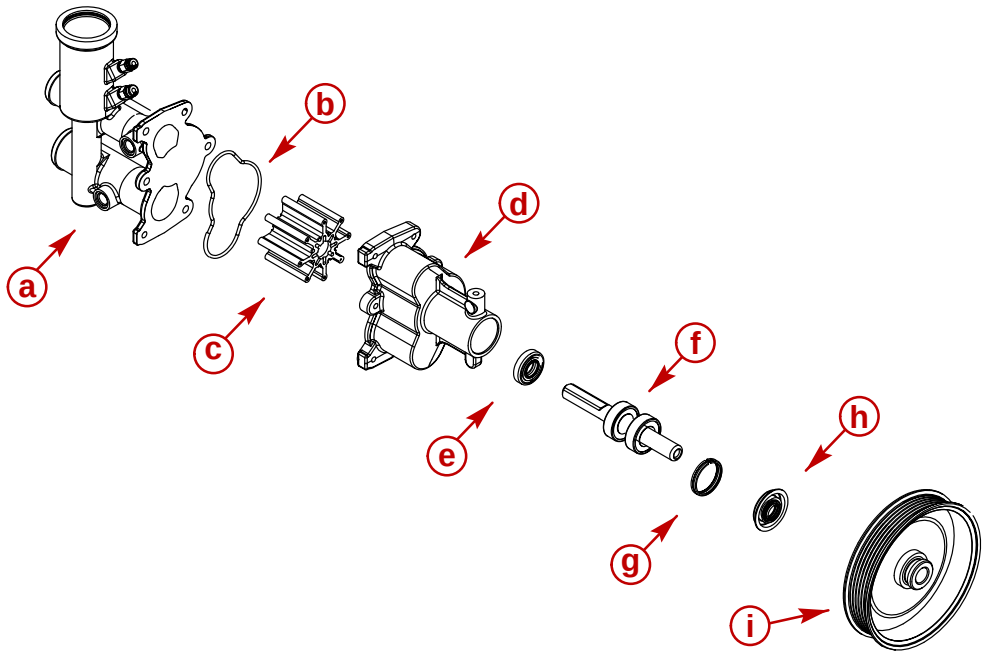
***NOTE:*** *Refer to the Alpha Sterndrive Service Manual for repair of the seawater pump.*

## Removal

1. Drain the seawater section of the cooling system.
2. Remove both of the hoses from the aft side of the seawater pump.
3. Remove the serpentine belt.
4. Remove the two bolts attaching the seawater pump and bracket to the engine.

## Disassembly

1. Press off the pulley.
2. Remove the six bolts from the rear of the seawater pump.
3. Remove and discard the O-ring.
4. Remove the impeller.
5. Remove the retainer/seal from the front of the seawater pump.
6. Remove the retainer ring.
7. From the impeller side, press the bearing shaft out of the housing.
8. Remove the rear oil seal from the housing.




78136

**a** - Seawater Pump Backplate
**b** - O-ring
**c** - Impeller
**d** - Seawater Pump Bearing Housing
**e** - Rear Oil Seal
**f** - Bearing Shaft Assembly
**g** - Tolerance Ring
**h** - Retainer/Seal
**i** - Pulley

## Cleaning and Inspection

1. Clean the metal parts in solvent and blow dry with compressed air.

**IMPORTANT: Do not spin the bearings at high speed when drying with compressed air, as the bearings may be scored.**

2. After cleaning, lightly coat the shaft and the bearings to prevent rust.

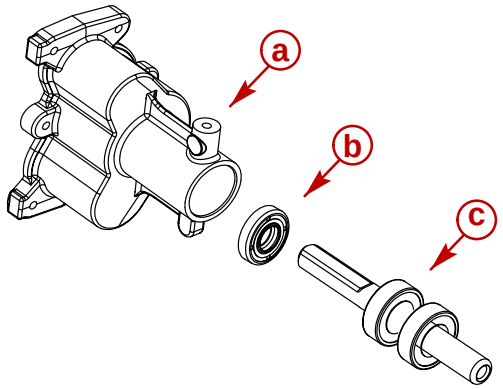
| Description | Where Used | Part Number |
|---|---|---|
| Engine Oil | Seawater pump bearing shaft | Obtain Locally |

3. Clean all gasket material and sealer from the sealing surfaces.
4. Inspect the bearing housing. Examine the surfaces (where the bearings contact the housing) for evidence of the bearing outer races turning in the housing.
5. Inspect the seals in the bearing housing.
6. Inspect the pump body.
7. Inspect the pump impeller for wear on the sides and the tips of the blades. Also inspect the blades for cracks in the area where the blades flex. Replace the impeller if the blades have taken a set (remain in curved position).
8. Inspect the pump pulley.
9. Inspect the serpentine drive belt for excessive wear.

## Reassembly

1. Place the rear oil seal into the bearing shaft housing with the side with the spring towards the main pump body.
2. Lubricate the bearing shaft assembly.

| Description | Where Used | Part Number |
|---|---|---|
| Engine Oil | Seawater pump bearing shaft | Obtain Locally |

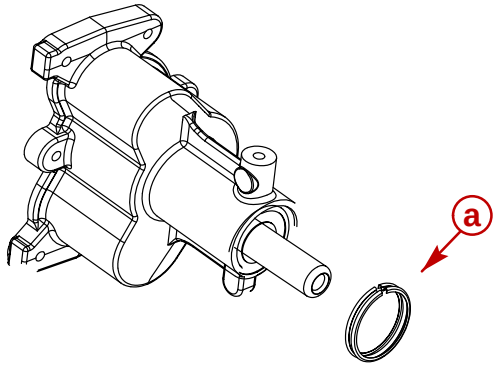



78137

**a** - Seawater Pump Bearing Housing
**b** - Rear Oil Seal
**c** - Bearing Shaft Assembly

3. Install the bearing shaft assembly into the housing.

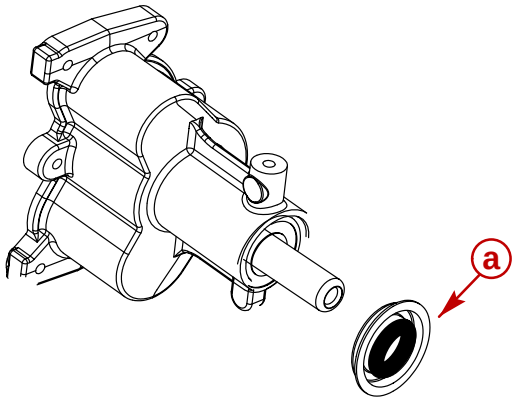
4. Install the tolerance ring.




78138

**a -** Tolerance Ring

5. Apply adhesive to the retainer/seal outer edges. Do NOT apply adhesive to the seal portion of the retainer.
6. Place retainer / seal on the shaft and press it into place.



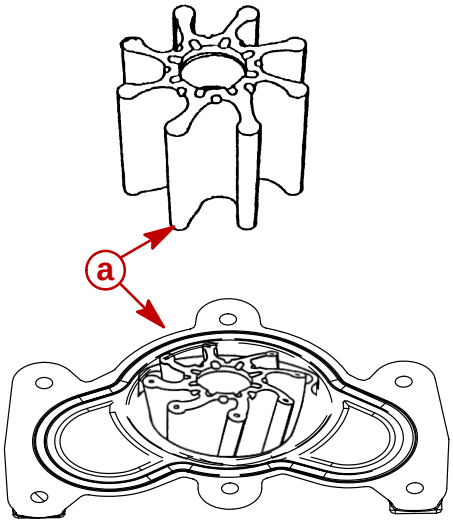

78139

**a -** Retainer/Seal

| Description | Where Used | Part Number |
|---|---|---|
| Loctite 609 | Seawater pump retainer/seal | Obtain Locally |

7. Wipe away excess adhesive.
8. Lubricate the impeller with soapy water.

9. Install the impeller into the pump body.

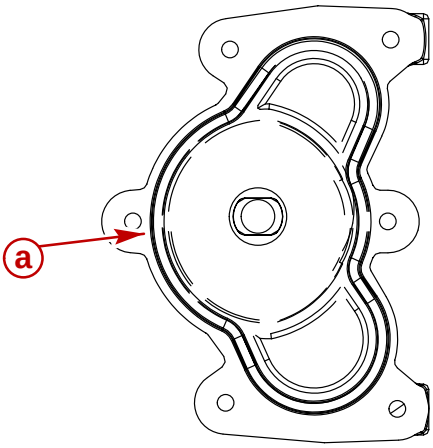



71118

71150

**a** - Impeller

10. Install the O-ring into the groove on the pump body.

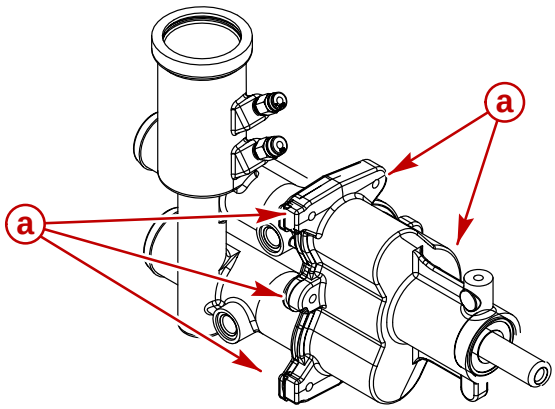



78140

**a** - O-ring Groove

11. Align pump body with the back plate.

12. Install the bolts and torque.




78141

**a -** Seawater Pump Bolts

| Description | Nm | lb-in. | lb-ft |
|---|---|---|---|
| Bolt, Seawater Pump | 9.9 | 88 | |

## Installation

1. Fasten the seawater pump and bracket to the engine. Torque the bolts.

| Description | Nm | lb-in. | lb-ft |
|---|---|---|---|
| Bolt, Seawater Pump Bracket-To-Engine | 41 | | 30 |

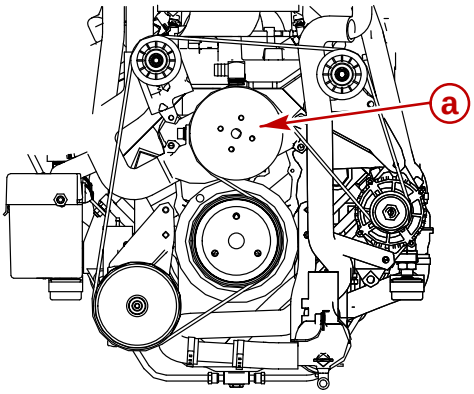
2. Attach the hoses to the aft side of the seawater pump. Tighten the hose clamps securely.
3. Press the pulley onto the seawater pump shaft.
4. Install the serpentine belt.

# Water Circulating Pump

## Removal

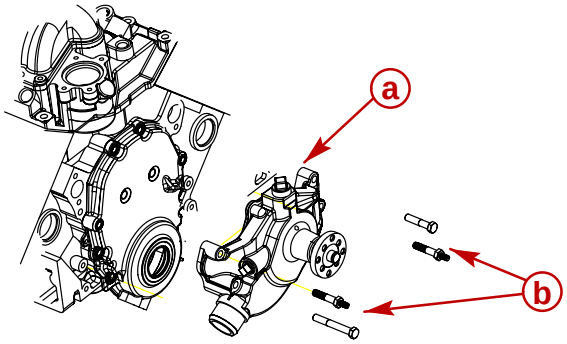
1. Allow engine to cool.
2. Drain the seawater and closed cooling (if equipped) sections of the engine.
3. Remove serpentine belt.
4. Remove the hoses attached to the water circulating pump.
5. Remove bolts and water pump pulley.

77954




**a** - Water Circulating Pump Pulley

6. Remove the fasteners and the water circulating pump.

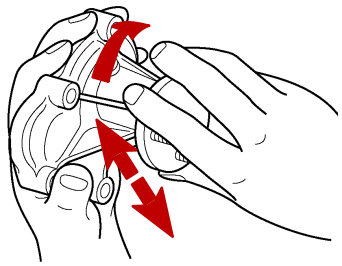



**a** - Water Circulating Pump
**b** - Fasteners

7. Remove and discard the old gaskets.

# Cleaning and Inspection

1. Clean sealing surfaces and remove sealant residue.
2. Check bearing for excessive radial play.
3. Check bearing for abnormal noise when turning the shaft.



77294

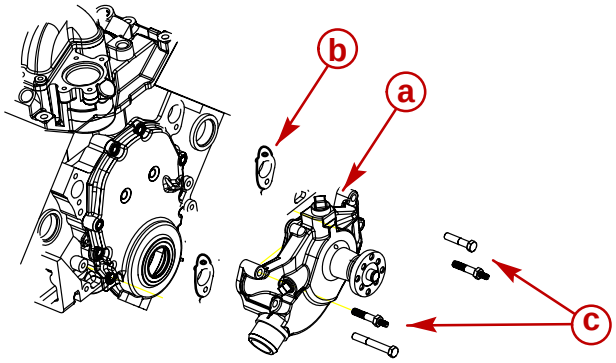
4. Check pump body for cracks.
5. Check seal for signs of leaking.
6. Check pump impeller for cracks, corrosion or damage.

# Installation

1. Coat both sides of the new circulating pump gaskets and the threads of the attaching fasteners with sealant.

| Description | Where Used | Part Number |
|---|---|---|
| Perfect Seal | Water Circulating Pump Gaskets And Fasteners | 92-34227-1 |

2. Install new water pump gaskets to cylinder block.
3. Install water pump. Torque bolts.




**a** - Water Circulating Pump
**b** - Gaskets
**c** - Fasteners

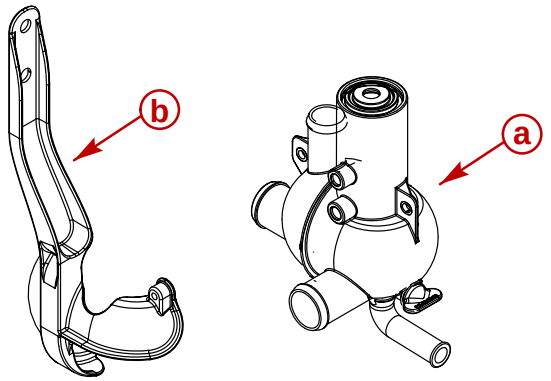
| Description | Nm | lb-in. | lb-ft |
|---|---|---|---|
| Fastener, Water Pump | 48 | | 35 |

4. Install water pump pulley to the water pump. Tighten the bolts securely.
5. Reconnect the hoses to the water pump.
6. Install the serpentine drive belt and adjust belt tension.
7. Fill closed cooling system, if equipped.
8. Supply cooling water to the engine.
9. Start the engine and check for leaks.

# Water Distribution Housing

## Removal

1. Drain the seawater section of the cooling system.
2. Disconnect the hoses from the water distribution housing.
3. Remove the bolt and nut attaching the water distribution housing and bracket to the engine.
4. Remove the bracket from the the water distribution housing.




78100

**a** - Water Distribution Housing
**b** - Bracket

## Cleaning And Inspection

1. Clean the water distribution housing with water and dry with a clean cloth or compressed air.
2. Inspect the housing for leaks, cracks or corrosion damage. Replace, if necessary.

## Installation

1. Align the water distribution housing with the bracket.
2. Attach the housing to the bracket. Torque the screws.

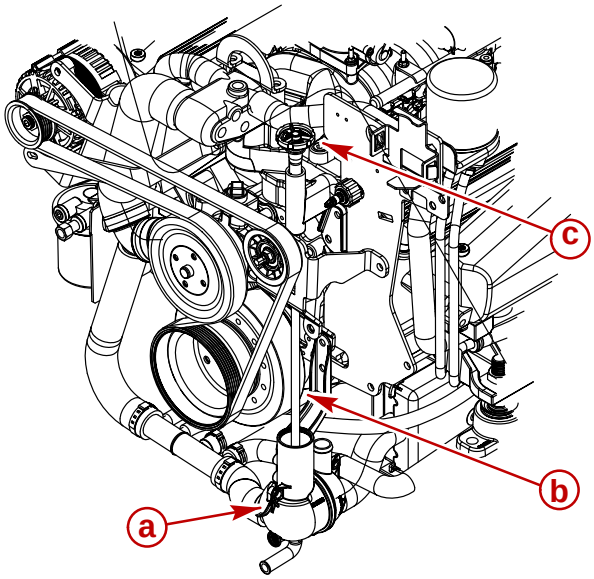
| Description | Nm | lb-in. | lb-ft |
|---|---|---|---|
| Screws, Water Distribution Housing-To-Bracket | 13.5 | 120 | |

3. Install the bracket and water distribution housing onto the engine. Finger-tighten the bolt and nut.

4. **On Manual Single Point Drain only:**

   a. Install the drain rod into the water distribution housing.

   b. Ensure the that the rod is correctly aligned. The rod must screw in and out of the water distribution housing easily and with little pressure.




77932

**a** - Water Distribution Housing
**b** - Drain Rod
**c** - Drain Rod Handle

5. Torque the bolt and nut attaching the bracket to the engine.

| Description | Nm | lb-in. | lb-ft |
|---|---|---|---|
| Fasteners, Water Distribution Housing Bracket | 38 | | 28 |

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# COOLING SYSTEM

## Section 6B - Seawater Cooled Models

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Seawater Cooled Models Without An Engine Mounted Seawater Pump 6B-7


6 B

# Torque Specifications

| Description | Nm | lb-in. | lb-ft |
|---|---|---|---|
| Screws, Thermostat Housing | 41 | | 30 |

# Lubricants / Sealants / Adhesives

| Description | Where Used | Part Number |
|---|---|---|
| Perfect Seal | Thermostat housing gasket | 92-34227-1 |

# Specifications

## Seawater Cooling System Capacity

| Engine | Liter (U.S. Quart) |
|---|---|
| All | 20 (21) |

## Thermostat

| Engine | Specification |
|---|---|
| All | 71 Degrees C (160 Degrees F) |

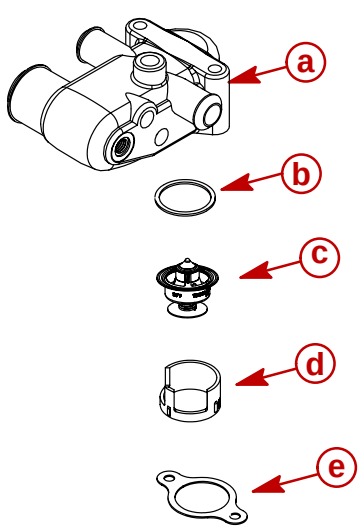
# Flushing Seawater Cooling System

Refer to Section 1B - Maintenance

# Thermostat

## Removal

1. Drain the water from the engine.
2. Remove the hoses from the thermostat housing.
3. Remove the thermostat housing assembly.
4. Remove the thermostat from the thermostat housing or the cover.

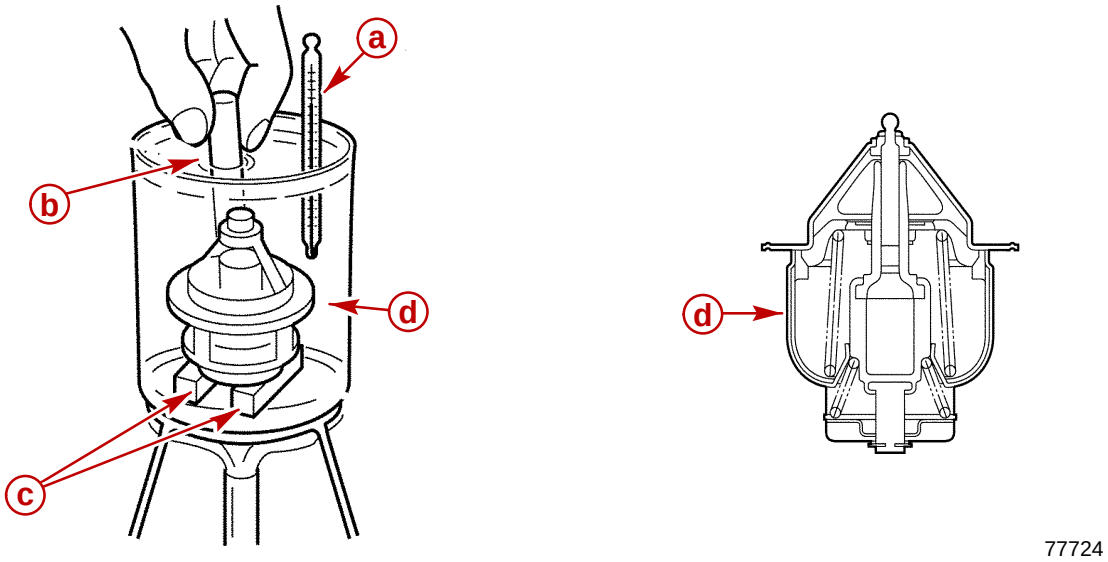



7825

**a** - Housing
**b** - O-ring
**c** - Thermostat (Stainless Steel)
**d** - Spacer
**e** - Gasket

## Testing

1. Remove the thermostat.
2. Place the thermostat on blocks in a container.
3. Completely submerge the thermostat in water.
4. Heat the water.
5. Stir the water constantly to avoid direct heat being applied to the thermostat.
6. Refer to Specifications:
   a. Check the thermostat initial opening temperature.
   b. Check the thermostat full opening temperature.
   c. Check valve lift at fully open position.




77724

**a** - Thermometer
**b** - Agitating Rod
**c** - Wooden Blocks
**d** - Thermostat

7. Replace if specifications are not met or damage is discovered during inspection.

# Installation

1. Clean the gasket surfaces on the thermostat housing and the intake manifold.

**IMPORTANT: The gasket has continuity rivets. Do not coat with Perfect Seal or the Audio Warning Temperature Switch may not work properly.**

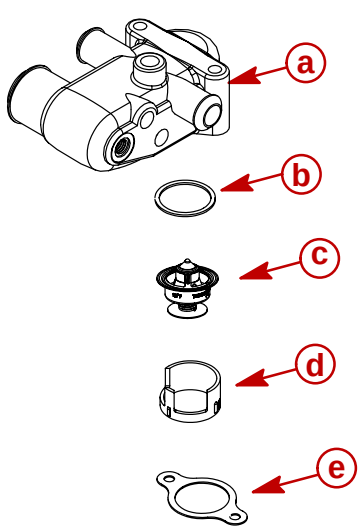
2. Place the O-ring in the thermostat housing. Be certain it is positioned properly in the housing.
3. Place the thermostat in the thermostat housing with the thermostatic element end toward the housing bottom.
4. Align the sleeve with the groove in the thermostat housing bore and install the sleeve into the housing.
5. Coat both sides of the new thermostat housing gasket with sealant and position on the intake manifold.

| Description | Where Used | Part Number |
|---|---|---|
| Perfect Seal | Thermostat housing gasket | 92-34227-1 |

6. Reinstall the thermostat housing and torque the screws .

| Description | Nm | lb-in. | lb-ft |
|---|---|---|---|
| Screws, Thermostat Housing | 41 | | 30 |

7. Reconnect the hoses to the thermostat housing. Tighten the hose clamps securely.
8. Start the engine and inspect for leaks.

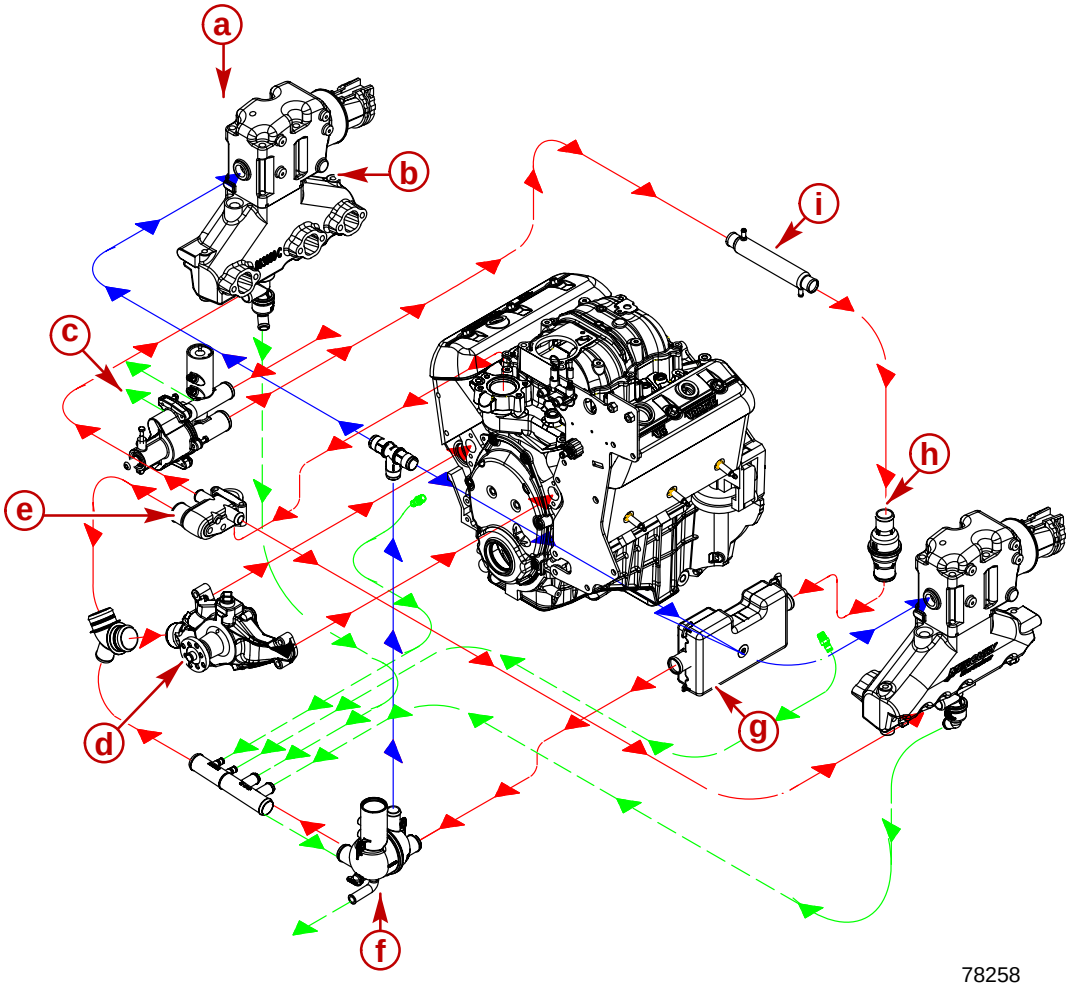



7825

**a** - Housing
**b** - O-Ring
**c** - Thermostat, Stainless Steel
**d** - Spacer
**e** - Gasket

# Water Flow Diagrams

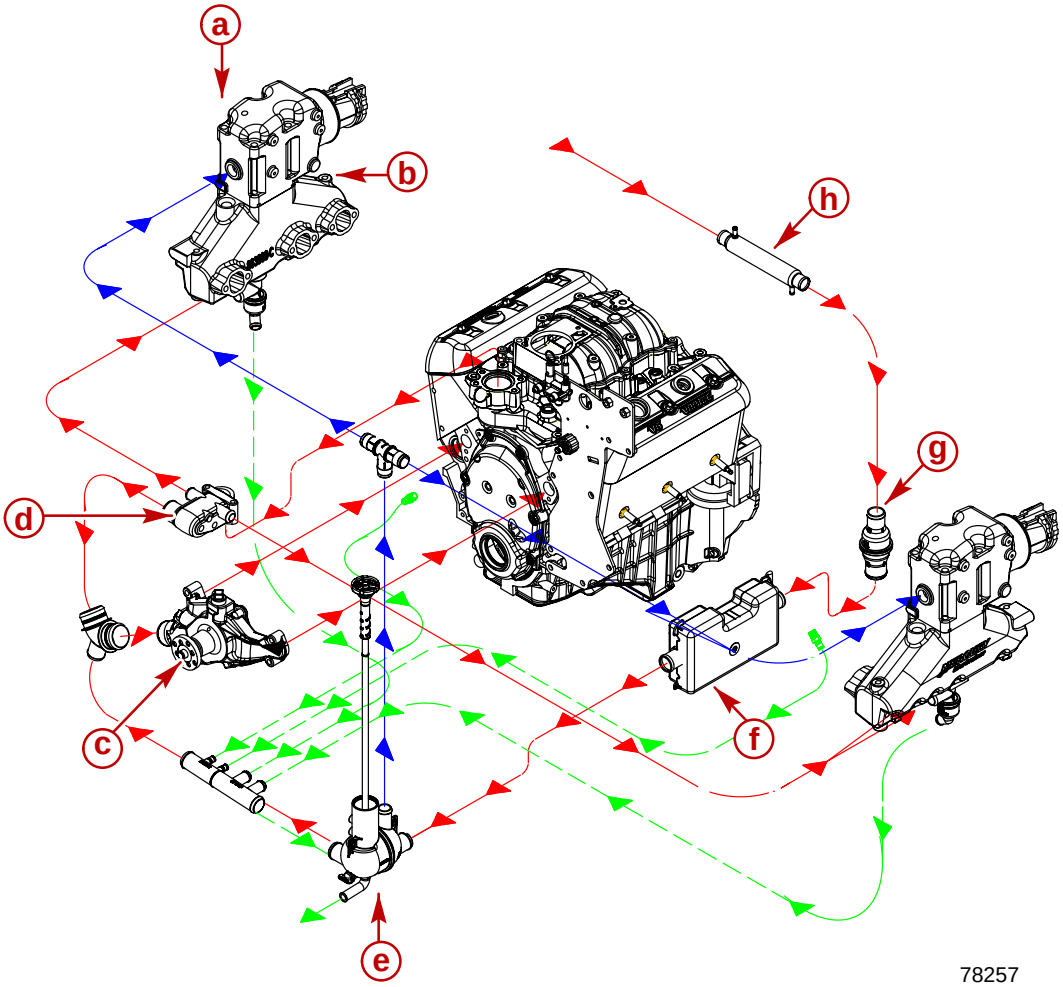
## Seawater Cooled Models With An Engine Mounted Seawater Pump




78258

**a** - Exhaust Elbow
**b** - Exhaust Manifold
**c** - Seawater Pump
**d** - Water Circulating Pump
**e** - Thermostat Housing
**f** - Water Distribution Housing
**g** - Cool Fuel Box
**h** - Check Valve
**i** - Power Steering Cooler

# Seawater Cooled Models Without An Engine Mounted Seawater Pump




**a** - Exhaust Elbow
**b** - Exhaust Manifold
**c** - Water Circulating Pump
**d** - Thermostat Housing
**e** - Water Distribution Housing
**f** - Cool Fuel Box
**g** - Check Valve
**h** - Power Steering Cooler

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# COOLING SYSTEM

## Section 6C - Closed Cooled Models

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6C

# Torque Specifications

| Description | Nm | lb-in. | lb-ft |
|---|---|---|---|
| Heat Exchanger End Cap | 6 | 54 | |
| Thermostat Cover | 41 | | 30 |
| Hose Clamps | Securely | | |
| Drain Plugs | | | |

# Lubricants / Sealants / Adhesives

| Description | Where Used | Part Number |
|---|---|---|
| Extended Life Coolant/Antifreeze | Closed Cooling System | 92-877770K1 |
| Perfect Seal | Heat Exchanger End Cap Gaskets | 92-34227-1 |

# Specifications

## Closed Cooling System Capacity

***NOTE:*** *All capacities are approximate fluid measures.*

| Model | Liters (U.S. Qts) |
|---|---|
| Seawater Cooling System | 20 (21) |
| Closed Cooling System | 19 (20) |

## Coolant Specification

| Closed Cooled Models |
|---|
| Extended Life Coolant 5/100 (Orange Color) |

## Thermostat

| Engine | Specifications |
|---|---|
| All Engines | 71 Degrees C (160 Degrees F) |

## Pressure Cap Rating

| Engine | Specifications |
|---|---|
| All Engines | 110 kPa (16 psi) |

# Description

The cooling system is composed of two separate subsystems: the seawater system and the closed cooling system. The seawater system is similar in function to the fan used in an automobile because it absorbs heat from the closed cooling system as it passes through the heat exchanger. The closed cooling system is similar in function to the rest of the cooling system in an automobile.

The coolant recovery system keeps the reservoir full. Normal coolant overflow into the recovery bottle is approximately 230 ml (1/2 pint) during warm-up. The coolant recovery system draws coolant back into the reservoir from the recovery bottle as the engine cools. As long as there is coolant in the recovery bottle, the reservoir should remain completely full. If not, there is a vacuum leak, usually at the hose leaving the reservoir or the gasket under the recovery filler cap.

**IMPORTANT: The coolant (antifreeze) flows around the outside of the cooling tubes while seawater flows through the inside of the cooling tubes in the heat exchanger.**

# Coolant Recommendations

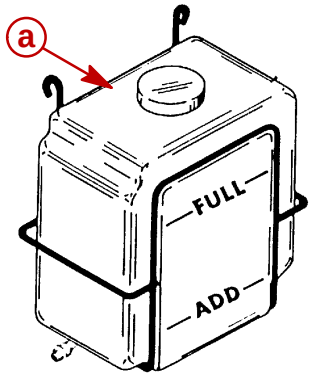
**⚠ CAUTION**

**Alcohol or Methanol base antifreeze or plain water are not recommended for use in the fresh water section of cooling system at any time.**

***NOTE:*** *All factory installed closed cooling systems come filled with Extended Life Coolant. This antifreeze requires draining and replacing every five years or 1000 hours of operation, whichever comes first. For best results any "top-off" fluid used should be Extended Life Coolant. If Extended Life Coolant is unavailable, any type of ethylene glycol based antifreeze may be used, but it will require the draining and replacing of the coolant every two years or 400 hours of operation, whichever comes first.*

In areas where the possibility of freezing DOES NOT exist, it is permissible to use a solution of rust inhibitor and water (mixed to manufacturer's recommendations).

# Maintaining Coolant Level




72520

**Coolant Recovery Bottle**

**a -** Fill Cap

Before starting the engine each day, ensure that the coolant is visible in the coolant recovery bottle.

If the coolant is not visible, check the closed cooling system (including the coolant recovery system) for leaks and repair. Refill with the recommended coolant solution as outlined under Changing Coolant.

If the coolant is visible, start the engine and operate until it reaches normal operating temperature, then recheck the coolant level in the coolant recovery bottle. The coolant level MUST be between the ADD and FULL marks on the front of the bottle.

**⚠ WARNING**

**Allow the engine to cool before removing the pressure cap. A sudden loss of pressure could cause the hot coolant to boil and discharge violently. After the engine has cooled, turn the cap 1/4 turn to allow any pressure to escape slowly, then push down and remove the cap.**

If the level is low, remove the fill cap from the coolant recovery bottle and add the required amount of coolant solution. Refer to Coolant Recommendations in this section.

Occasionally, ensure that the coolant recovery system is functioning properly by removing the pressure cap from the heat exchanger and checking the level. The coolant level should be up to the bottom of the heat exchanger filler neck. If low, examine the entire fresh water section (especially the coolant recovery system) for leaks and repair.

**IMPORTANT: When reinstalling the pressure cap, tighten it until it contacts the stops on the filler neck.**

# Pressure Cap Maintenance

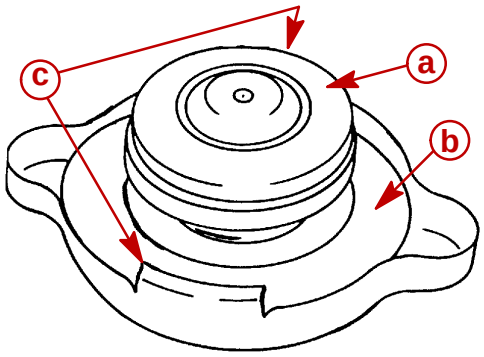
The pressure cap should maintain pressure the closed cooling system at normal engine operating temperature. This raises the boiling point of the coolant, thereby increasing the efficiency of the cooling system. To help ensure proper operation, the cap should be cleaned, inspected and pressure tested periodically.

**⚠ WARNING**

**Allow the engine to cool before removing the pressure cap. A sudden loss of pressure could cause hot coolant to boil and discharge violently. After the engine has cooled, turn the cap 1/4 turn to allow any pressure to escape slowly, then push down and turn the cap all the way off.**

1. Remove the pressure cap from the heat exchanger.
2. Wash the cap with clean water to remove any deposits or debris from the sealing surfaces.
3. Inspect the rubber seal on the cap for cuts, cracks or other signs of deterioration. If the seal is damaged, the cap MUST be replaced.
4. Inspect the coolant recovery gasket for deterioration and replace if bad.
5. Check the condition of the locking tabs on the cap. Replace the cap if the tabs are bent or cracked.
6. Check the gasket for cracks or other damage.

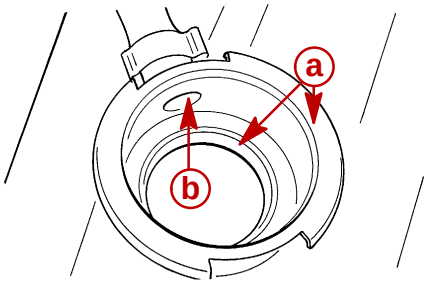
**IMPORTANT: The cap MUST be replaced if damaged.**




72714

**a** - Rubber Seal
**b** - Gasket
**c** - Locking Tabs (1 Not Shown)

7. Test the pressure cap.
8. Clean the sealing surfaces on the heat exchanger filler neck with a cloth. Inspect the surfaces for any damage or deposits that may prevent the cap from sealing properly.
9. Clean the coolant recovery passage in the heat exchanger filler neck with a wire and blow out with compressed air.




72715

**a** - Sealing Surfaces
**b** - Coolant Recovery Passages

10. Reinstall the pressure cap. Tighten the cap until it contacts the filler neck.

# Testing Closed Cooling System

## Testing Coolant for Alkalinity

**⚠ WARNING**

**Allow the engine to cool before removing the pressure cap. A sudden loss of pressure could cause hot coolant to boil and discharge violently. After the engine has cooled, turn the cap 1/4 turn to allow any pressure to escape slowly, then push down and turn the cap all the way off.**

The coolant should be changed per the Maintenance Schedule recommendations and should be checked for alkalinity at least once between change intervals. To check the coolant for alkalinity, proceed as follows:

1. Obtain pink litmus paper from a locally.
2. Allow the engine to cool and remove the pressure cap from the heat exchanger and insert one end of the litmus paper into the coolant.
3. **If pink litmus paper turns blue,** the coolant is alkaline and need not be replaced.
4. **If pink litmus paper remains pink,** the coolant is not alkaline and MUST BE REPLACED, as explained under Changing Coolant.

# Pressure Testing System

**⚠ WARNING**

**Allow the engine to cool before removing the pressure cap. A Sudden loss of pressure could cause hot coolant to boil and discharge violently. After the engine has cooled, turn the cap 1/4 turn to allow any pressure to escape slowly, then push down and turn the cap all the way off.**

If the coolant section of the closed cooling system is suspected of leaking or not holding sufficient pressure, and no visible signs of leakage can be found, perform the following test:

1. Remove the pressure cap from the heat exchanger or the reservoir.
2. Clean, inspect and pressure test the pressure cap.
3. Clean the inside of the filler neck to remove any deposits or debris. Examine the lower inside sealing surface for damage. The surface must be perfectly smooth to achieve a good seal between it and the rubber seal on the cap. Ensure that the locking cams on the sides of the filler neck are not bent or damaged.
4. Adjust the coolant level in the fresh water section to 25 mm (1 in.) below the filler neck.
5. Attach an automotive-type cooling system pressure tester to the filler neck and pressurize closed cooling section to amount specified in following chart.

| Pressure Cap Rating | Amount of Pressure Applied to Closed Cooling System |
|---|---|
| 110 kPa (16 psi) | 138 kPa (20 psi) |

6. Observe the gauge reading for approximately two minutes; the pressure should not drop during this time. If the pressure drops, proceed with the following steps until leakage is found.
7. While maintaining the specified pressure on the closed cooling section, visually inspect the external portion of the cooling system (hoses, gaskets, drain plugs, petcocks, core plugs, circulating pump seal, etc.) for leakage. Also listen closely for bubbling or hissing.
8. Test the heat exchanger.

9. If no leakage could be found in the above steps, the engine is leaking internally. Leaking may be caused by one or more of the following: loose cylinder head bolts or damaged gasket, loose intake manifold bolts or damaged gasket, loose exhaust elbow or distribution block retaining nuts or damaged gasket, cracked or porous cylinder head or block or cracked or porous exhaust manifold. Proceed as follows until the location of the internal leak is found.

   a. Start the engine. Re-pressurize the system to the previously specified amount and observe the pressure gauge on the tester. If the needle in the gauge vibrates, the compression or the combustion is leaking into the closed cooling section from a leak in the combustion chamber. Exact cylinders where the leakage is taking place can sometimes be found by removing the spark plug wires (one at a time) while observing the pressure gauge. Vibration will decrease or stop when the plug wire is removed from the leaking cylinder. Stop the engine.

   b. Remove the spark plugs (one at a time) from the cylinders and examine for the presence of coolant. A spark plug that is perfectly clean or milky appearing is a sure indication of a leak.

   c. Drain the oil from the engine and examine for coolant. Oil will usually be milky if coolant is present. If coolant is present, remove the engine from the boat and drop the oil pan. With the engine in the upright position, re-pressurize the closed cooling section to the previously specified amount and examine the internal surfaces of the engine to locate the leak.

   d. If no leakage can be found in the above steps, the entire engine must be disassembled and inspected for leaks.

# Testing for Cylinder Head Gasket Leak

A leaking head gasket will cause combustion gas to be forced into the cooling system. The mixture of coolant and tiny air bubbles is a poor heat conductor and will overheat an engine quickly. Compression tests or cooling system pressure check normally will not detect the leak because the test pressure is far below the combustion pressures that cause the leak. An effective test is as follows:

**IMPORTANT: Operate the boat in the water for this test. It is best to operate the engine at or above cruising speed during this test. Usually a failed head gasket will not cause the engine to overheat below cruising speed.**

1. Install a clear plastic hose between the reservoir and the coolant recovery bottle. Use a 610-910 mm (2-3 ft) long hose for this test.
2. Route this hose so a U is formed.
3. Put enough coolant into the hose to fill the center 100-130 mm (4-5 in.) of the U-shape.
4. Observe the U-shape while the engine is operating.
    a. **During Idle and Warm-Up:** Some coolant and/or air will leave the reservoir.
    b. **During Cruising Speed (2500-3500 rpm):** Coolant and/or air leaving the reservoir should stop after approximately five minutes operating at a given rpm. A leaking head gasket will produce air bubbling through the U-shape, going to the coolant recovery bottle. The frequency and size of the bubbles will depend on the size of the leak.
    c. **At Higher Speeds (4000+ rpm):** Normal operation is the same as described above. A failed head gasket will cause the bubbles to come faster and may be accompanied by violent, intermittent bursts of coolant.

Do not confuse normal warm-up expansion with a failed head gasket. Normal warm-up produces an intermittent flow of coolant that will stop within approximately five minutes at a given rpm. A head gasket leak will not stop because the one thing that marks a failed head gasket is the continued passage of air. This may be accompanied by violent, intermittent bursts of coolant leaving the reservoir. If coolant flows evenly from the reservoir at cruising speed, something other than the head gasket is causing the engine to overheat.

# Testing Pressure Cap

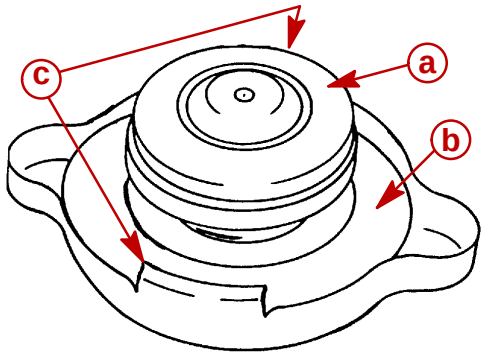
The pressure cap is designed to maintain a pressure of approximately its rated capacity once the engine has attained operating temperature. The cap should be cleaned, inspected and pressure-tested at regular intervals or whenever the cap is suspected of maintaining improper pressure.

**⚠ WARNING**

**Allow the engine to cool before removing the pressure cap. A sudden loss of pressure could cause hot coolant to boil and discharge violently. After the engine has cooled, turn the cap 1/4 turn to allow any pressure to escape slowly, then push down and turn the cap all the way off.**

1. Carefully remove the pressure cap from the reservoir or the heat exchanger.
2. Wash the cap with clean water to remove any deposits or debris from the sealing surfaces.
3. Inspect the gasket (if used) and the rubber seal on the cap for tears, cuts, cracks or other signs of deterioration. Replace the gasket, if damaged.
4. Replace the cap if the rubber seal is damaged.
5. Check the condition of the locking tabs on the cap. Replace the cap if the tabs are bent or cracked.

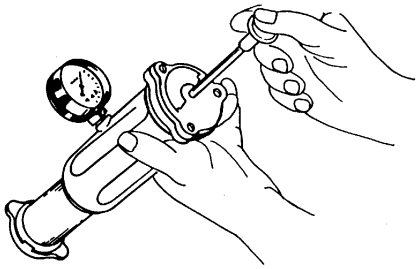
**IMPORTANT: The cap MUST be replaced if damaged.**




72714

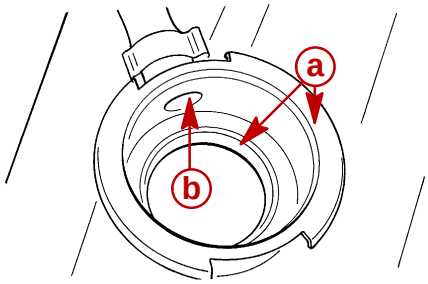
**a** - Rubber Seal
**b** - Gasket
**c** - Locking Tabs (1 not shown)

6. Using a cooling system pressure tester (similar to one shown), test the cap to ensure that it releases at the proper pressure and does not leak. (Refer to the instructions which accompany the tester for the correct test procedure.) The cap must relieve pressure at 110 kPa (16 psi), and must hold the rated pressure for 30 seconds without going below 75.8 kPa (11 psi). Replace the cap if it fails to fall within these limits.



72716

**IMPORTANT: Before reinstalling the cap in the next step, examine the lower inside sealing surface in the filler neck to ensure that it is perfectly smooth and free of debris. Also, inspect the cam lock flanges on the sides of the filler neck to ensure that they are not bent.**




72715

**a -** Sealing Surfaces
**b -** Coolant Recovery Passages

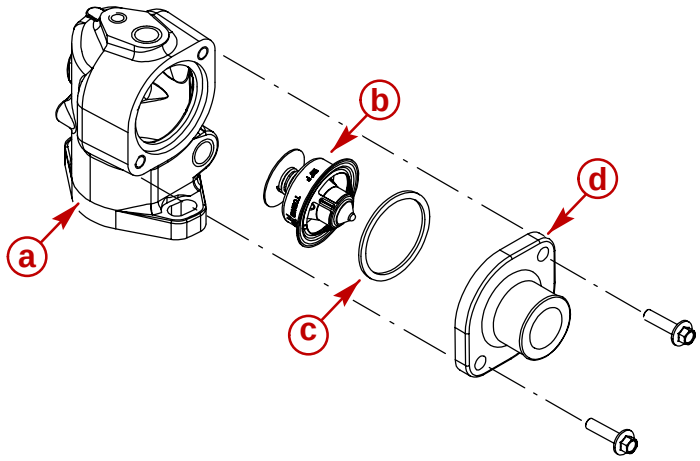
7. Reinstall the cap on the reservoir or the heat exchanger.

# Thermostat

## Removal

***NOTE:*** *If the coolant flow is restricted or fails to occur, a wire should be repeatedly inserted into all drain holes to ensure that there are no obstructions in the passages. Remove the fitting, if necessary, to insert the wire completely into the drain hole.*

1. Drain the engine.
2. Disconnect the hoses from the thermostat cover.
3. Remove the thermostat cover attaching bolts and the lockwashers, then remove the cover and the gasket.
4. Remove the thermostat from the thermostat housing.

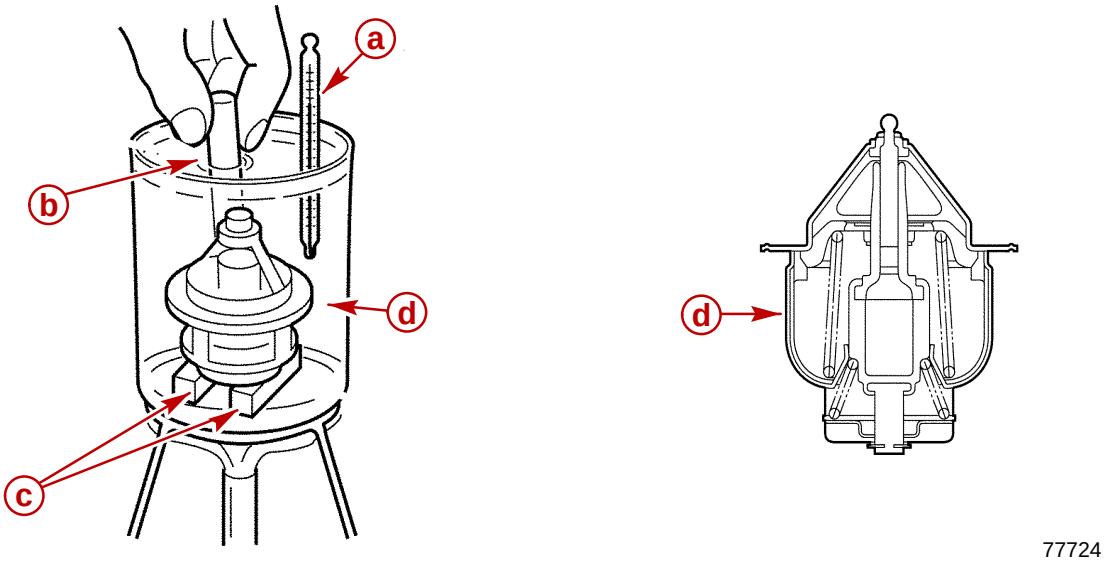



78148

**a** - Thermostat Housing
**b** - Thermostat
**c** - Gasket
**d** - Thermostat Housing Cover

## Testing

1. Remove the thermostat.
2. Place the thermostat on blocks in a container.
3. Completely submerge the thermostat in water.
4. Heat the water.
5. Stir the water constantly to avoid direct heat being applied to the thermostat.
6. Refer to Specifications:
   a. Check the thermostat initial opening temperature.
   b. Check the thermostat full opening temperature.
   c. Check valve lift at fully open position.




77724

**a** - Thermometer
**b** - Agitating Rod
**c** - Wooden Blocks
**d** - Thermostat

7. Replace if specifications are not met or damage is discovered during inspection.

# Installation

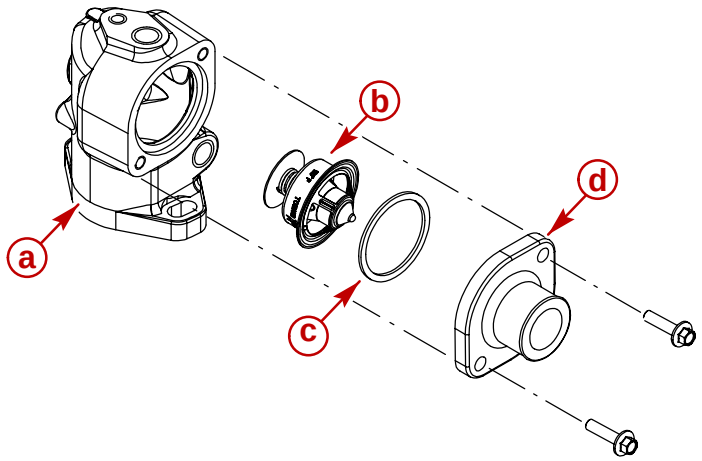
**⚠ CAUTION**

**Avoid seawater pickup pump impeller damage. DO NOT operate the engine without cooling water being supplied to the seawater pickup pump.**

1. Remove the thermostat housing and the gaskets. Discard the gaskets.
2. Clean the gasket surfaces on the thermostat cover, the thermostat housing and the intake manifold.
3. Position the gasket on the intake manifold. Place the thermostat housing on the gasket.

**IMPORTANT: If the gasket has continuity rivets, do NOT coat with Perfect Seal, or the audio warning temperature switch may not work properly.**

4. Install the thermostat into the thermostat housing.
5. Position the gasket on the thermostat and reinstall the thermostat cover. Torque the bolts.




78148

**a** - Thermostat Housing
**b** - Thermostat
**c** - Gasket
**d** - Thermostat Housing Cover

| Description | Nm | lb-in. | lb-ft |
|---|---|---|---|
| Bolt, Thermostat Cover | 41 | | 30 |

6. Connect the hoses to the thermostat cover. Tighten the hose clamps securely.
7. Supply cooling water start the engine and inspect for leaks.

# Heat Exchanger

## Testing

### INTERNAL LEAKS

An internal leak will cause coolant to go into the seawater circuit when pressure is put on the closed cooling circuit.

1. Remove a seawater hose from the exchanger. Do not drain the exchanger.
2. Pressurize the closed cooling circuit to 110-138 kPa (16-20 psi) with a radiator tester.
3. If seawater begins to flow from the seawater hose fitting, there is a leak.

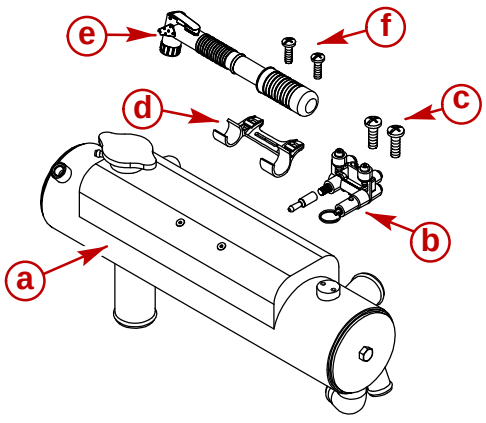
### FOR BLOCKAGE

**IMPORTANT: Seawater flows THROUGH the tubes in the exchanger. Closed cooling coolant flows AROUND the tubes.**

1. Remove the end caps and inspect for any blockage in the seawater circuit (broken impeller blades, weeds, etc.).
2. Remove the closed cooling circuit hoses and inspect the tubes just inside the nipples. Because the complete exchanger cannot be inspected, the heat exchanger should be replaced if blockage is suspected.

## Removal

1. Allow engine to cool.
2. Drain the seawater and closed cooling systems.
3. Remove the hoses from the heat exchanger.
4. Remove the air manifold hoses from the air actuator by pushing in on the bottom of the manifold and pulling the hoses out.



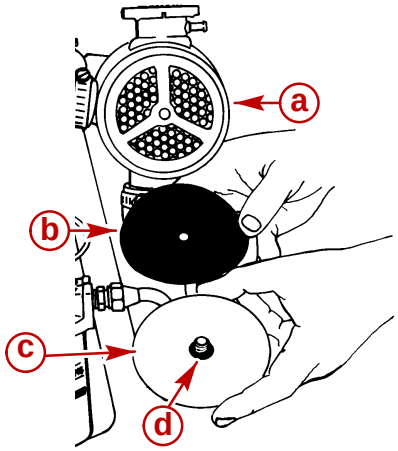

78148

**a** - Heat Exchanger
**b** - Air Manifold
**c** - Bolts
**d** - Air pump Bracket
**e** - Air pump
**f** - Screws

5. Remove the 2 large hose clamps fastening the heat exchanger to the engine.
6. Remove the heat exchanger.

## Disassembly

1. Remove the air pump from the air pump bracket.
2. Remove the air pump bracket.
3. Remove the air manifold.
4. Remove the screws attaching the end plates to the heat exchanger.




71515

**a-** Heat Exchanger
**b-** Sealing Washer
**c-** End Cap
**d-** Gasket

5. Remove the end plates and gaskets.

## Cleaning And Inspection

1. Clean old gasket material and sealant from surfaces. Do not nick or gouge the surfaces.
2. Use a long rod to clean out heat exchanger tubes.
3. Inspect each part for cracks or other damage. Replace as necessary.
4. Clean and paint exterior surfaces as required to prevent corrosion.

## Repair

**IMPORTANT: Braze with BCUP 2 rod or silver solder. Care must be taken not to melt the other joints during repair.**

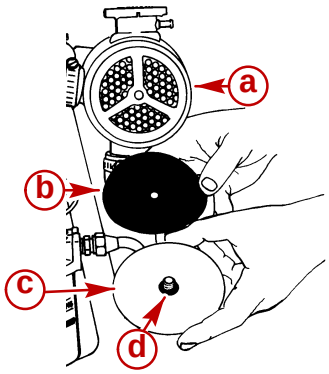
1. Internal leaks can be repaired by brazing shut the ends of the leaking tube. This is only a temporary fix because usually another tube will start leaking after a short period of time and this also causes a reduction in the cooling capacity. Do not close more than three tubes.
2. Fittings and drains that have been broken off the heat exchanger can be reattached by brazing.

## Assembly

1. Apply sealant to both sides of new end plate gaskets.

| Description | Where Used | Part Number |
|---|---|---|
| Perfect Seal | Heat Exchanger End Cap Gaskets | 92-34227-1 |

2. Install new gaskets, new sealing washers and end plates onto heat exchanger. Torque the end plate screws.

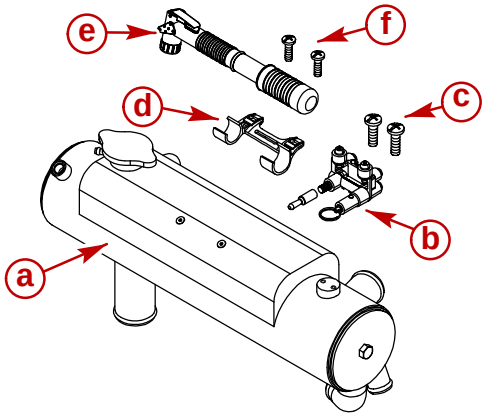



71515

**a -** Heat Exchanger
**b -** Sealing Washer
**c -** End Cap
**d -** Gasket

| Description | Nm | lb-in. | lb-ft |
|---|---|---|---|
| Heat Exchanger End Cap | 6 | 54 | |

3. Fasten the air pump bracket to the heat exchanger. Tighten the screws securely.
4. Fasten the air manifold to the heat exchanger. Tighten the bolts securely.

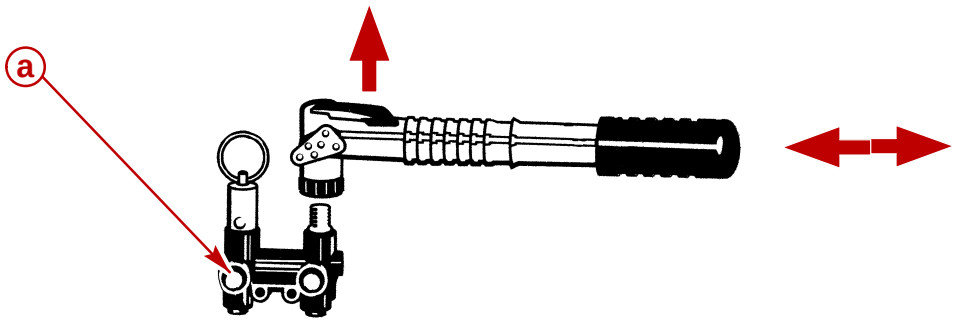



78148

**a -** Heat Exchanger
**b -** Air Manifold
**c -** Bolts
**d -** Air pump Bracket
**e -** Air pump
**f -** Screws

# Installation

1. Lower heat exchanger onto bracket and simultaneously attach water hoses.
2. Ensure that all hose ends are aligned and fully seated on heat exchanger fittings. Tighten all hose clamps securely.
3. Install large hose clamps around heat exchanger bracket and heat exchanger. Tighten securely.
4. Install the air lines to the air manifold.
5. Ensure the air lines are installed properly, as follows:
   a. Install air pump on the fitting in the air manifold.

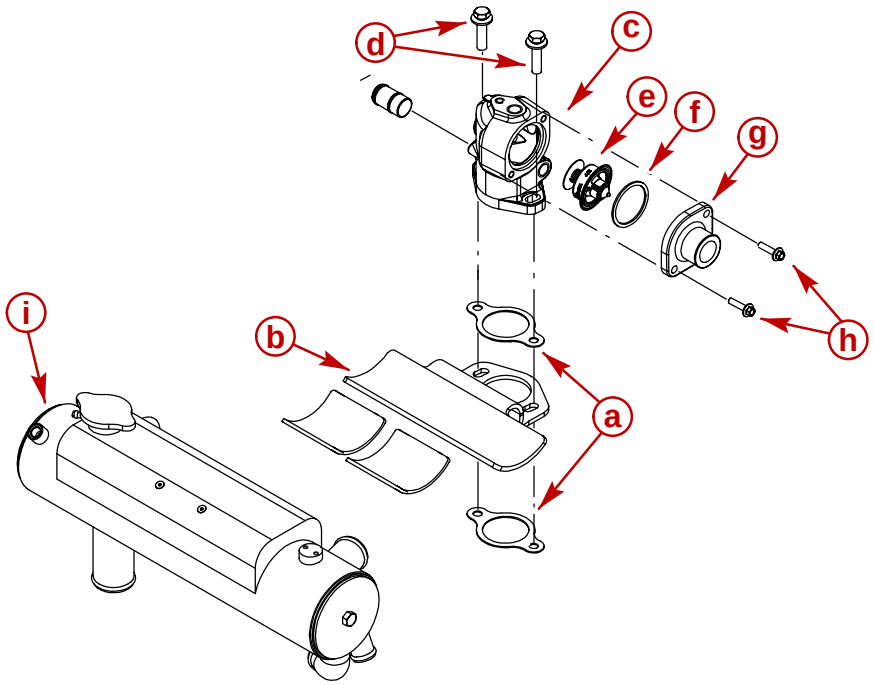



77638

**a -** Green Indicators

   b. Pull lever on air pump up (vertical) to lock pump on the fitting.
   c. Pump air into the system until both green indicators extend, if the green indicators do not extend the air lines are not attached properly.
6. Fill closed cooled system. Refer to SECTION 1B.

# Heat Exchanger Bracket Hardware

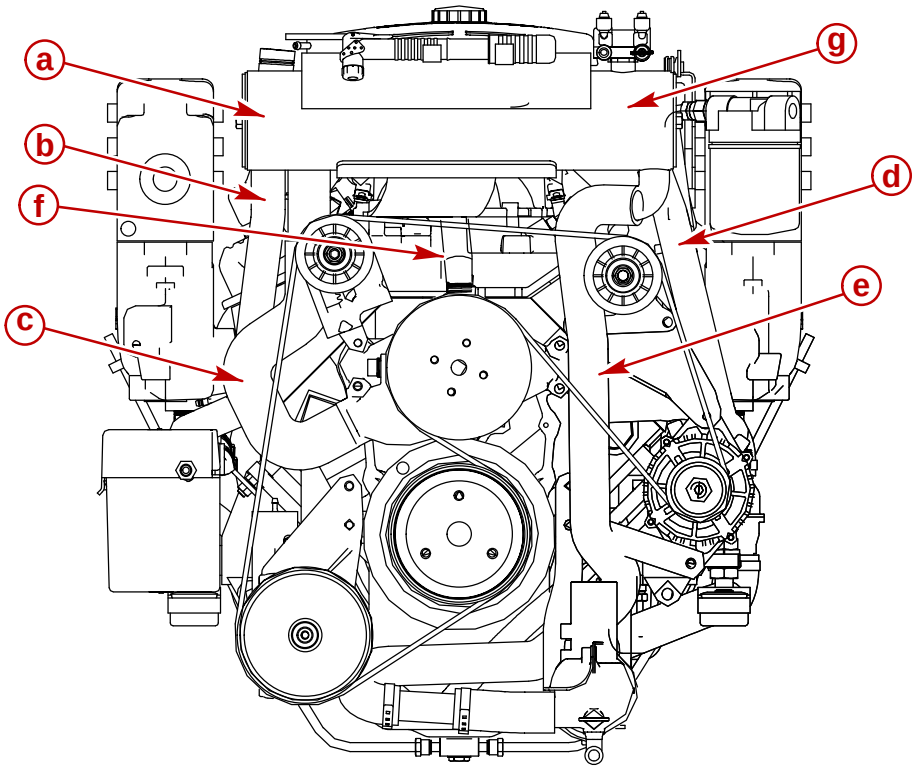



78148

**Typical Engine Shown**

**a** - Gasket
**b** - Heat Exchanger Bracket And Pads
**c** - Thermostat Housing
**d** - Screws
**e** - Thermostat
**f** - Quad-Ring Seal
**g** - Thermostat Cover
**h** - Screws
**i** - Heat Exchanger

# Heat Exchanger Hose Connections



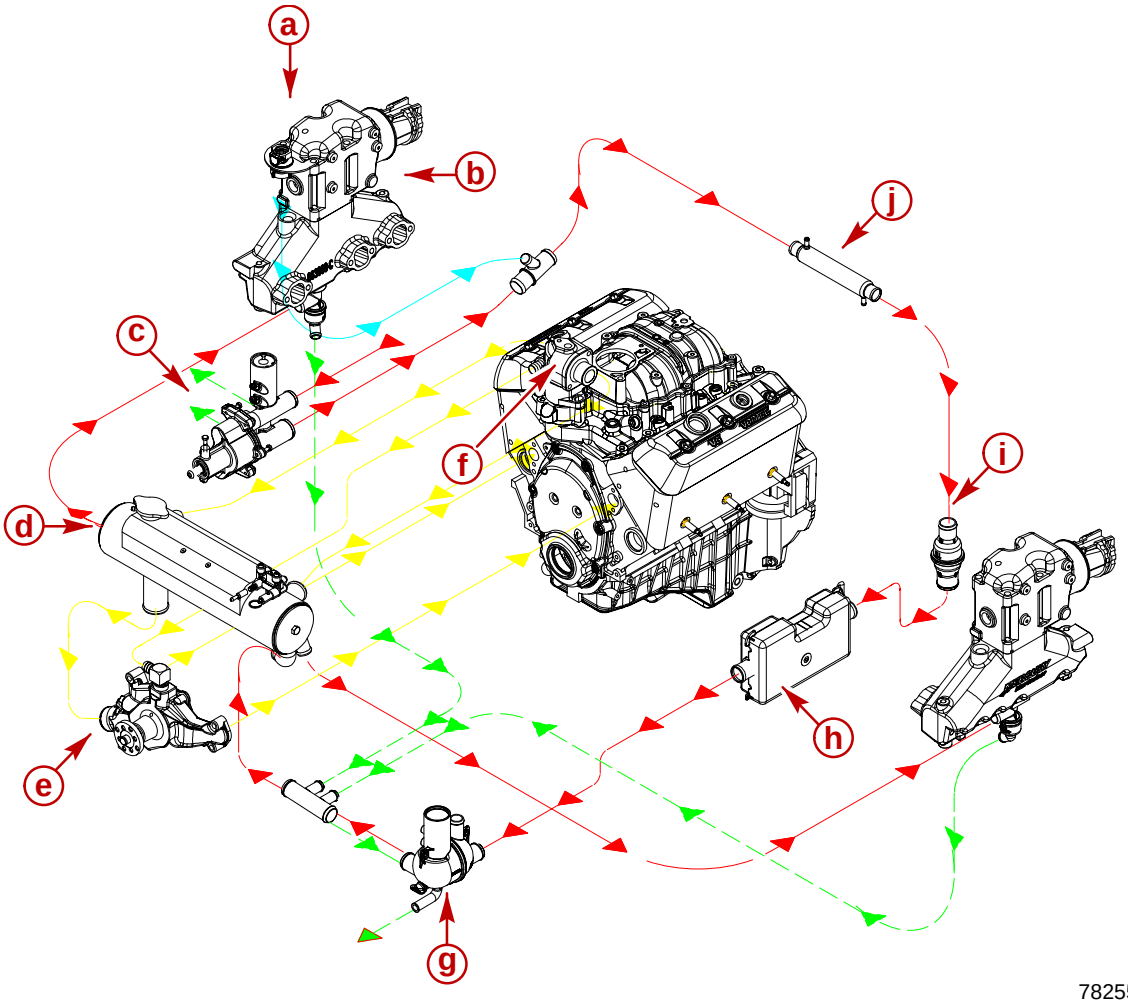

77954

**Typical Engine Shown**

- **a** - Heat Exchanger
- **b** - Starboard Heat Exchanger-To-Exhaust Manifold Hose
- **c** - Water Circulating Pump Hose
- **d** - Port Heat Exchanger-To-Exhaust Manifold Hose (MCM)
- **e** - Cool Fuel System-To-Heat Exchanger Hose
- **f** - Heat Exchanger Bypass Hose
- **g** - Coolant Identification Decal
- **h** - Thermostat Housing-To-Heat Exchanger Hose (Not Visible)

# Closed Cooling System Water Flow Diagram

## Closed Cooled Models




78255

**a** - Exhaust Elbow
**b** - Exhaust Manifold
**c** - Seawater Pump
**d** - Heat Exchanger
**e** - Water Circulating Pump
**f** - Thermostat Housing
**g** - Water Distribution Housing
**h** - Cool Fuel Box
**i** - Check Valve
**j** - Power Steering Cooler
**k** - Flush Fitting (Inboard Models)
**l** - Flush Connection (Inboard Models)
**m** - Shaft Log Seal Connection Point

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# EXHAUST SYSTEMS

## Section 7A - Manifolds, Elbows And Risers

## Table of Contents


Torque Specifications . . . . . 7A-2
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Cleaning and Inspection . . . . . 7A-6
Manifold Leak Test . . . . . 7A-7
Installation . . . . . 7A-7


7
A

# Torque Specifications

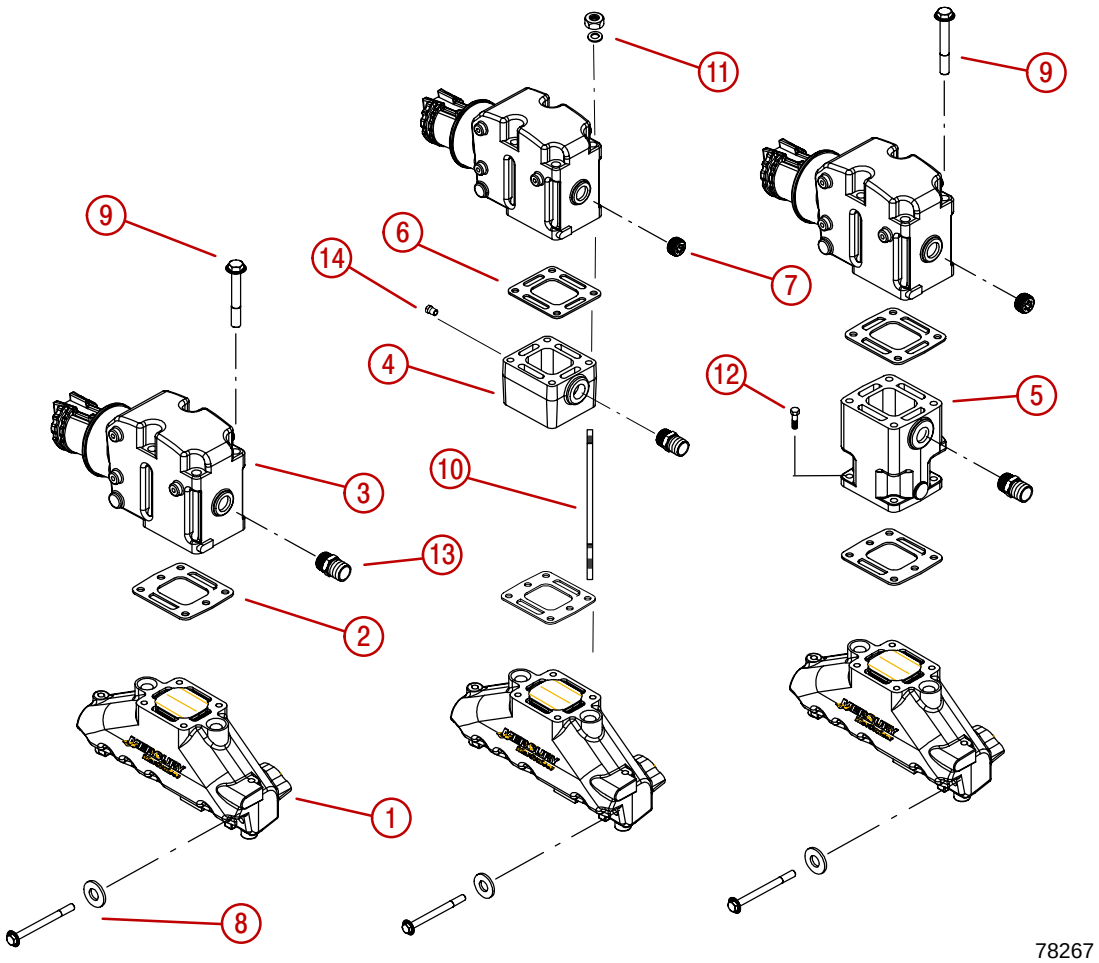
***NOTE:*** *Securely tighten all fasteners not listed below.*

| Description | Nm | lb-in. | lb-ft |
|---|---|---|---|
| Bolt, Exhaust Elbow To Exhaust Manifold | 45 | | 33 |
| Bolt, Exhaust Manifold To Cylinder Head | 34 | | 25 |
| Bolt, 6 Inch Riser To Exhaust Manifold | 45 | | 33 |

# Lubricants / Sealants / Adhesives

| Description | Where Used | Part Number |
|---|---|---|
| Perfect Seal | Exhaust Manifold And Elbow Plugs | 92-34227-1 |

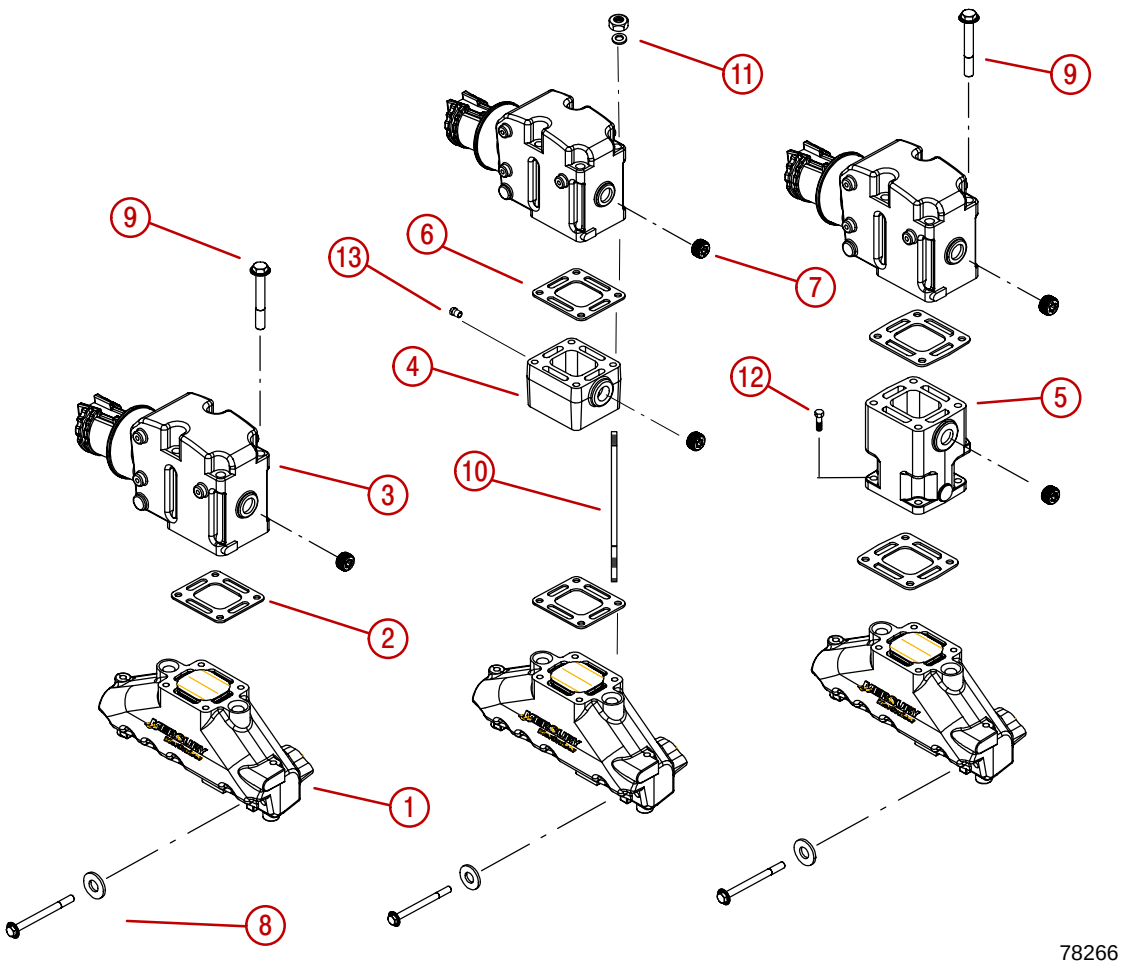
# Exploded View – Seawater Cooled Models




**No Riser** **3 Inch Riser** **6 Inch Riser**

**1** - Exhaust Manifold
**2** - Restrictor Gasket
**3** - Exhaust Elbow
**4** - 3 Inch Riser
**5** - 6 Inch Riser
**6** - Open Gasket
**7** - Plug
**8** - Bolt And Washer, Manifold-To-Cylinder Head
**9** - Bolt, Exhaust Elbow-To-Exhaust Manifold
**10** - Stud
**11** - Nut And Washer, Exhaust Elbow-To-3 Inch Riser
**12** - Bolt, 6 Inch Riser-To-Exhaust Manifold
**13** - Hose Fitting
**14** - Pipe Plug

# Exploded View – Closed Cooled Models




**No Riser** **3 Inch Riser** **6 Inch Riser**

**1** - Exhaust Manifold
**2** - Open Gasket
**3** - Exhaust Elbow
**4** - 3 Inch Riser
**5** - 6 Inch Riser
**6** - Open Gasket
**7** - Plug
**8** - Bolt And Washer, Manifold-To-Cylinder Head
**9** - Bolt, Exhaust Elbow-To-Exhaust Manifold
**10** - Stud
**11** - Nut And Washer, Exhaust Elbow-To-3 Inch Riser
**12** - Bolt, 6 Inch Riser-To-Exhaust Manifold
**13** - Pipe Plug

# Removal

**⚠ WARNING**

**Avoid possible injury or damage to equipment should wires be accidentally shorted. Disconnect BOTH battery cables from the battery before proceeding.**

1. Disconnect both battery cables from the battery.

**⚠ CAUTION**

**To avoid severe engine damage, exhaust elbows and manifolds MUST BE drained to prevent water from entering the combustion chambers when the exhaust elbows are removed.**

2. Drain the seawater section of the engine. Refer to SECTION 1B.
3. Disconnect the exhaust hoses and the cooling hoses from the exhaust manifold and elbow.
4. Remove the shift plate.
5. Remove the ECM and the ECM bracket.
6. Remove any other components that are mounted to the manifold, the elbow and the riser.
7. Remove the elbow and the riser.
8. Remove the exhaust manifold and discard the gaskets.

# Cleaning And Inspection

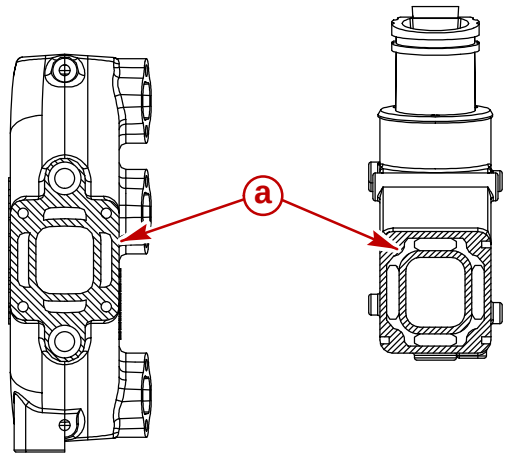
1. Clean the gasket material from all surfaces and wash the parts in solvent.
2. Inspect the water passages for foreign material. The passages must be clean for efficient cooling.

***NOTE:*** *If more thorough inspection is desired, the pipe plugs may be removed from the exhaust manifold and the exhaust elbow.*

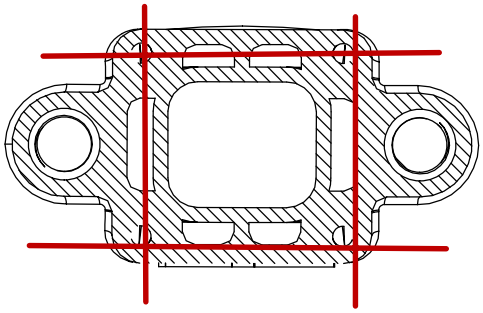
**IMPORTANT: If the pipe plugs are removed, coat the threads with sealant before reinstalling.**

| Description | Where Used | Part Number |
|---|---|---|
| Perfect Seal | Exhaust Manifold And Elbow Plugs | 92-34227-1 |

3. Inspect for cracks.
4. Inspect all parts carefully. Machined surfaces must be clean and free of all marks and deep scratches or water and exhaust leaks may result.
5. Inspect for damaged metal caused by saltwater or exhaust gas corrosion in the manifold, elbow and riser.
6. Measure the surface flatness of all gasket surfaces on the manifold, elbow and riser.




78265



77836

**a -** Gasket Surfaces

| Description | | mm (in.) |
|---|---|---|
| Surface Flatness | Maximum overall difference | 0.07 (0.003) |
| | Difference within 25 mm (1 in.) | 0.02 (0.001) |

***NOTE:*** *The maximum material that can be removed is 0.25 mm (0.010 in.). When torquing the attaching bolts, ensure that they are not contacting the bottom of the threaded hole in the manifold.*

7. Replace all damaged components.

# Manifold Leak Test

***NOTE:*** *One block-off plate must have an attachment for a compressed air hose.*

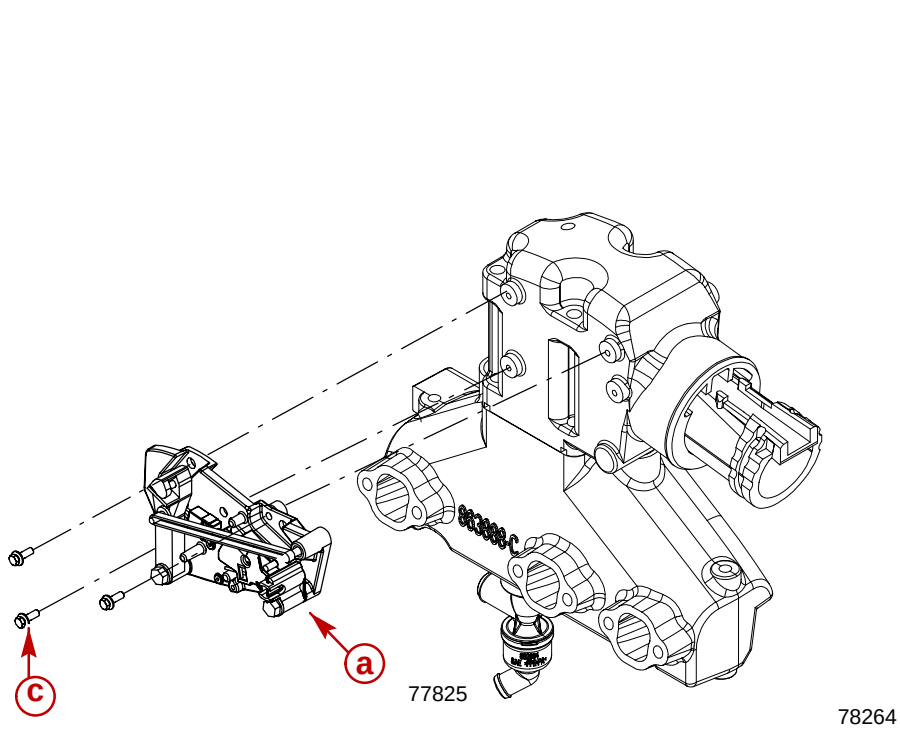
1. Using suitable block-off plates, plugs and new gaskets, seal the manifold openings.
2. Attach an air hose to the block-off plate.
3. Apply 276 kPa (40 psi) of air pressure and submerge the manifold in water.
4. Air bubbles will indicate a leak. Repair or replace, if necessary.

# Installation

1. Using a new gasket, install the exhaust manifold, elbow and riser to the cylinder head.
2. Torque the bolts.

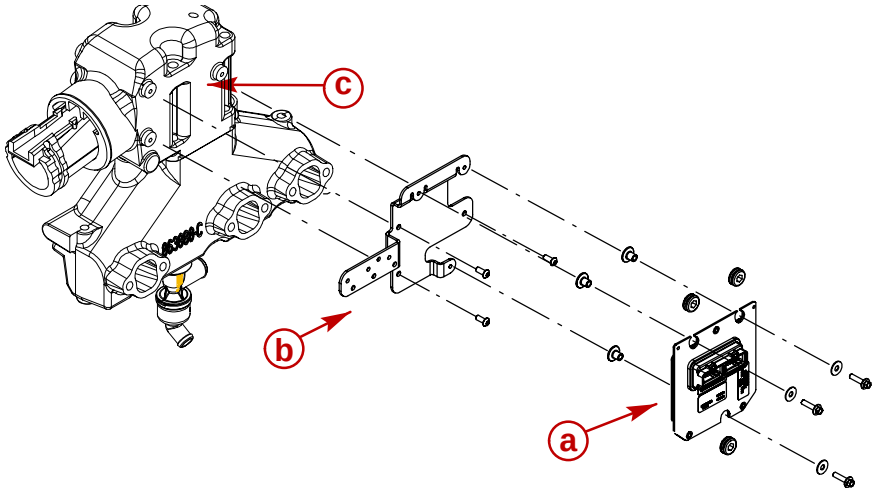
| Description | Nm | lb-in. | lb-ft |
|---|---|---|---|
| Bolt, Exhaust Elbow To Exhaust Manifold | 45 | | 33 |
| Bolt, Exhaust Manifold To Cylinder Head | 34 | | 25 |
| Bolt, 6 Inch Riser To Exhaust Manifold | 45 | | 33 |

3. **Starboard Exhaust Elbow:**
   a. Install the drop-down shift plate bracket, if equipped.
   b. Install the shift plate assembly to the elbow.
   c. Tighten securely.




**a** - Shift Plate
**b** - Exhaust Elbow
**c** - Bolts

4. **Port Exhaust Elbow:**
   a. Install the ECM drop-down bracket, if equipped.
   b. Install the ECM bracket and the ECM to the exhaust elbow.
   c. Tighten securely.




77825

**a** - ECM
**b** - ECM Bracket
**c** - Exhaust Elbow

5. Install the exhaust hoses and the cooling hoses.
6. Tighten hose clamps securely.
7. Install any additional components removed during disassembly.
8. Reconnect the battery cables to the battery. Tighten securely.

**⚠ CAUTION**

**Overheating from insufficient cooling water will cause engine and drive system damage. Ensure that there is sufficient water always available at water inlet holes during operation.**

9. Supply cooling water to the engine.
10. Start the engine and check for exhaust and water leaks.

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# POWER STEERING

## Section 8A - Power Steering Pump

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8
A

# Torque Specifications

| Description | Nm | lb-in. | lb-ft |
|---|---|---|---|
| Fitting Assembly | 47 | | 35 |
| Pump Mounting Bracket | 41 | | 30 |
| Power Steering Hose Fittings | 31 | | 23 |

# Lubricants / Sealants / Adhesives

| Description | Where Used | Part Number |
|---|---|---|
| Power Trim and Steering Fluid | Pump shaft | 92-802880Q1 |

# Special Tools

| Mercury MerCruiser Special Tools | |
|---|---|
| Mercury Marine<br>W6250 Pioneer Rd., P.O. Box 1939<br>Fond Du Lac, WI 54936-1939<br>Phone: 1-800-487-MERC<br>Fax: 1-800-457-8736<br>www.mercurymarine.com | |
| **Description** | **Part Number** |
| Pulley Pusher Installer Tool | 91-93656A1 |

| Snap-On Special Tools | |
|---|---|
| Snap-On Tools<br>2801 80th Street<br>Kenosha, WI 53141<br>See Snap-On Catalog<br>for your regions distributor phone number. | |
| **Description** | **Part Number** |
| Snap-On Special Puller Tool | CJ124A |
| Pulley Removal Tool | CJ117C |

| Kent-Moore Special Tools | |
|---|---|
| Kent-Moore Tools, Inc.<br>29784 Little Mack<br>Roseville, MI 48066<br>Phone: (313) 774-9500 | |
| **Description** | **Part Number** |
| Pulley Removal Tool | J-25034 |

# Precautions

**⚠ WARNING**

**Avoid personal injury or death and power package damage from an electrical shock, fire or explosion. Always disconnect both battery cables from the battery before servicing the power package.**

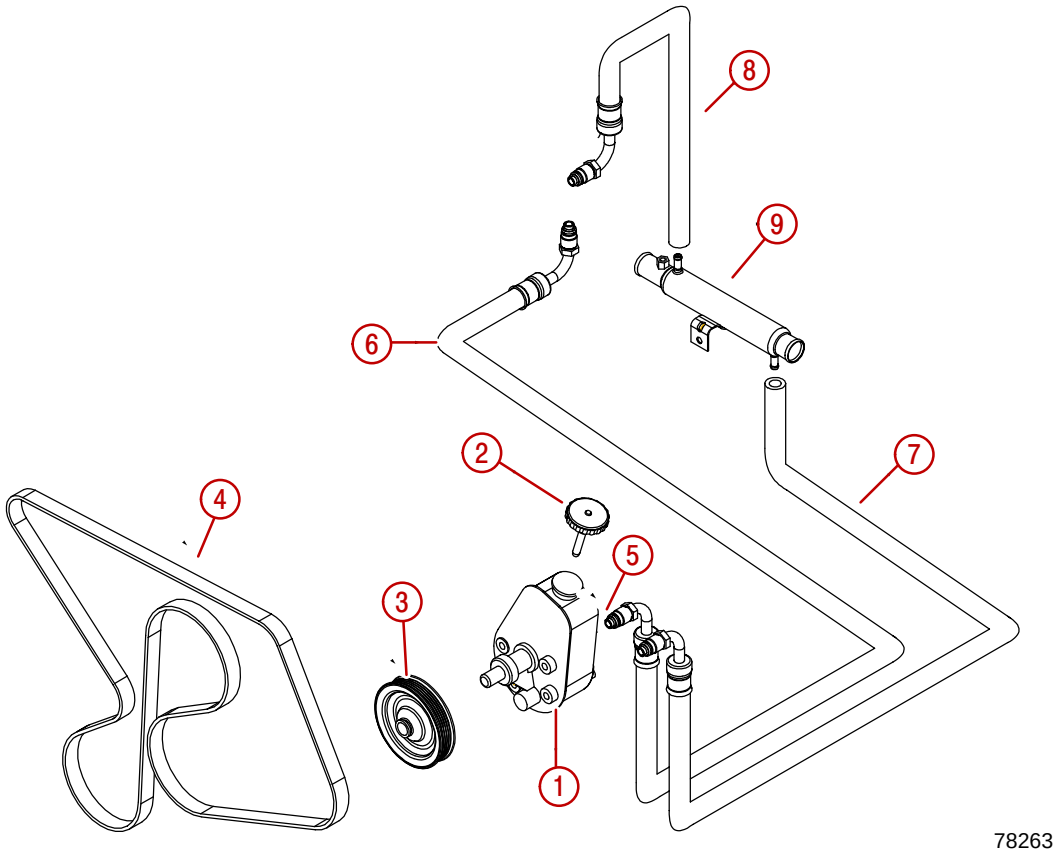
**⚠ CAUTION**

**Overheating from insufficient cooling water will cause engine and drive system damage. Ensure that there is sufficient water always available at water inlet holes during operation.**

**⚠ CAUTION**

**Do not pry on the power steering pump or the alternator when adjusting belt tension. Serious damage may result.**

# Power Steering Pump And Components Exploded View

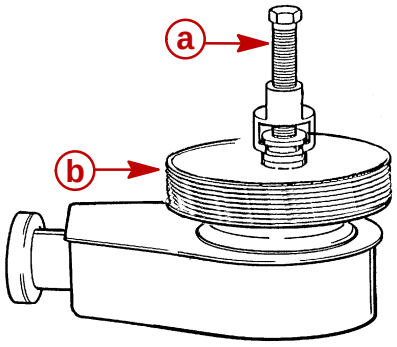



**1** - Power Steering Pump Assembly
**2** - Cap
**3** - Pulley
**4** - Serpentine Belt
**5** - O-ring, High Pressure Hose Fitting
**6** - Hose, High Pressure (Fittings On Both Ends)
**7** - Hose, Low Pressure
**8** - Hose, Control Valve To-Fluid-Cooler (Fitting On One End)
**9** - Power Steering Cooler

# Power Steering Pump Pulley Replacement

## Removal

1. Install the appropriate puller on the end of the pulley and the shaft.
2. While holding the puller with a suitable wrench, turn the threaded bolt until the pulley is removed.

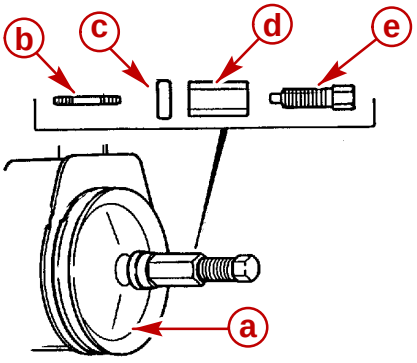



72821

**a** – Typical Puller
**b** – Power Steering Pump Pulley

## Installation

1. Thread the stud from the pulley installer completely into the pump shaft.
2. Place the pulley on the pump shaft.
3. Place the bearing over the stud.
4. Thread the nut onto the shaft tool.
5. Thread the tool shaft and the nut onto the stud (threaded into the pump shaft).
6. Turn the nut until the face of the pulley is even with the edge of the shaft.




75751

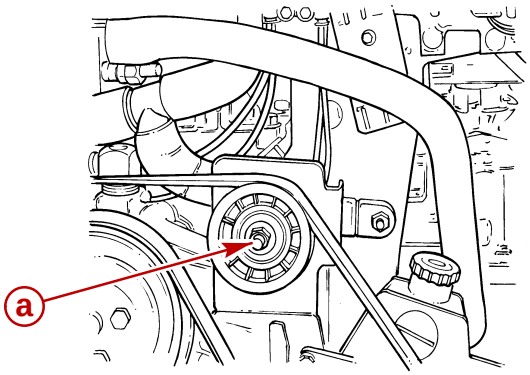
**Typical Pulley Installer**

**a** – Power Steering Pump Pulley
**b** – Stud
**c** – Bearing
**d** – Nut
**e** – Tool Shaft

# Power Steering Pump

## Removal

1. Loosen the adjusting nut and remove the serpentine belt from the power steering pulley.



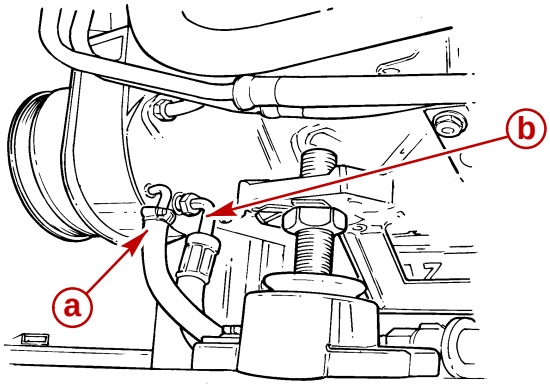

77827

**a** – Adjusting Nut

**⚠ CAUTION**

**ENVIRONMENTAL HAZARD! Discharge of oil or oil waste into the environment is restricted by law. Do not spill oil or oil waste into the environment when using or servicing your boat. Contain and dispose of oil or oil waste as defined by local authorities.**

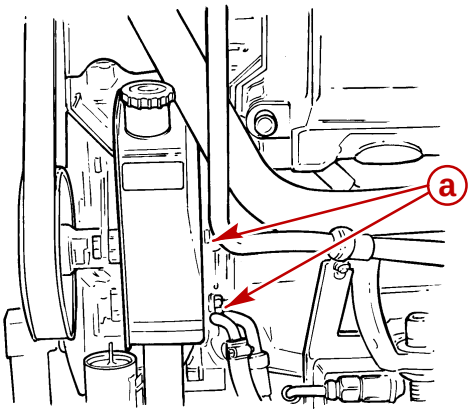
2. Drain the fluid into a suitable container.
3. Remove the high pressure hose and the return hose from the power steering pump.



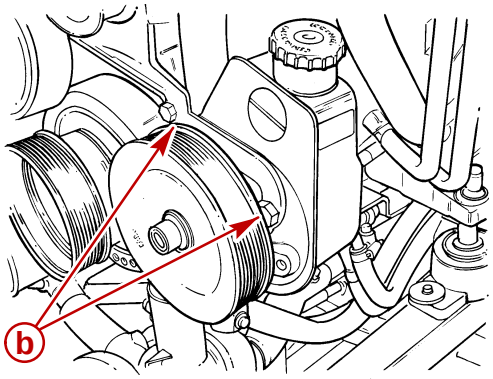

77827

**a** – Low Pressure Hose
**b** – High Pressure Hose

4. Remove the mounting fasteners from the pump.




77829



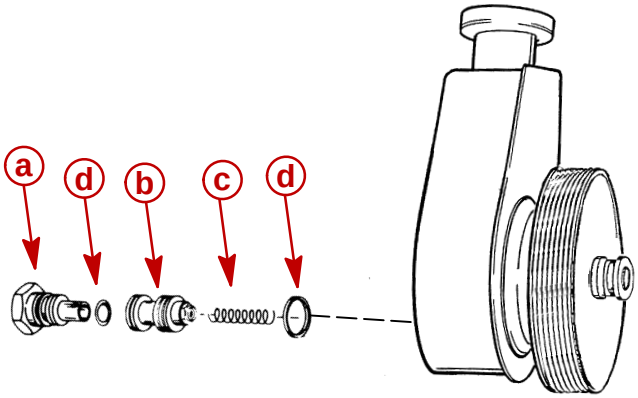

77830

**a** – Nut
**b** – Bolts

5. Remove the front bracket from the pump.
6. Remove the power steering pump from the bracket.

## Flow Control Valve Servicing

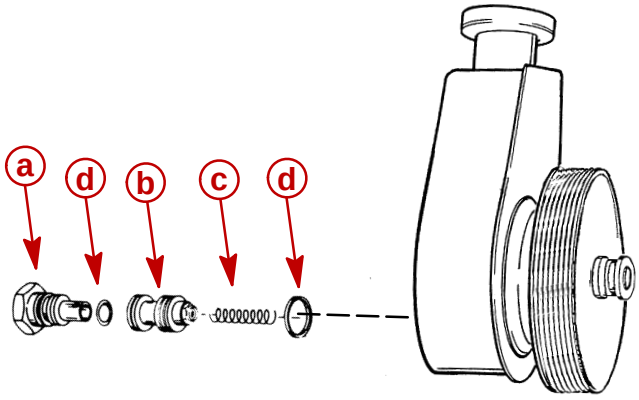
1. Drain the fluid from the pump.
2. Remove the high pressure fitting assembly.




76869

**a** – High Pressure Fitting
**b** – Control Valve Assembly
**c** – Flow Control Spring
**d** – O-rings

3. Inspect the control valve assembly and the fitting assembly for contamination and damage.
4. Install the components and torque the fitting assembly.



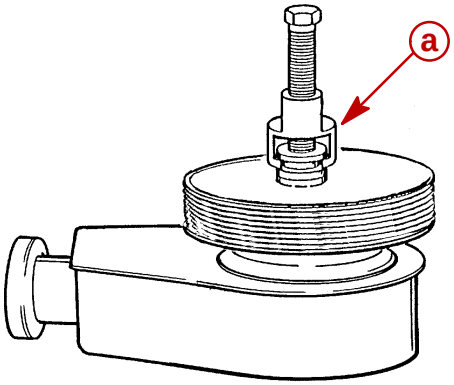

76869

**a** – Fitting Assembly
**b** – Control Valve Assembly
**c** – Flow Control Spring
**d** – New O-rings

| Description | Nm | lb-in. | lb-ft |
|---|---|---|---|
| Fitting Assembly | 47 | | 35 |

## Pump Shaft Oil Seal Replacement

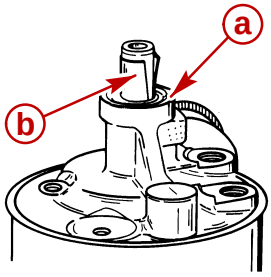
1. Remove the power steering pump pulley.




72821

**a** – Kent Moore Pulley Removal Tool (J25034)

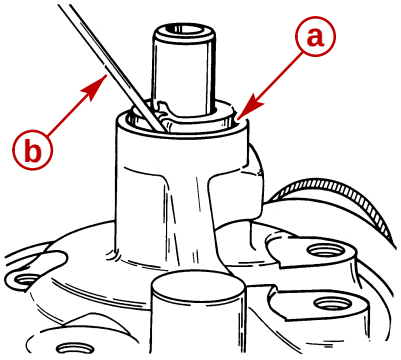
2. Push a 0.13 mm (.005 in.) shim stock past the oil seal until it seats in the pump body (approximately 64 mm [2-1/2 in.] long).




76830

**a** – Oil Seal
**b** – Shim Stock

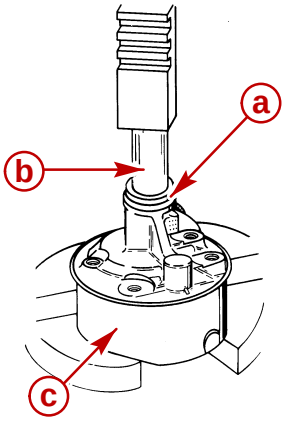
3. Remove the oil seal. Remove the shim stock.




22152

**a** – Oil Seal
**b** – Suitable Tool

4. Install the new oil seal metal side up. Properly support the pump reservoir so that the reservoir back does not distort.




22151

**a** – New Oil Seal
**b** – Suitable Mandrel
**c** – Pump Reservoir

5. Install the pulley, as follows, using the Pulley Pusher Installer:

| Description | Part Number |
|---|---|
| Pulley Pusher Installer | 91-93656A1 |

a. Grease the pump shaft and place the power steering pulley pump onto the pump shaft.

| Description | Where Used | Part Number |
|---|---|---|
| Power Trim and Steering Fluid | Pump shaft | 92-802880Q1 |

b. Thread the stud all the way into the pump shaft. Place the bearing over the stud. Do NOT use the spacer from the kit.

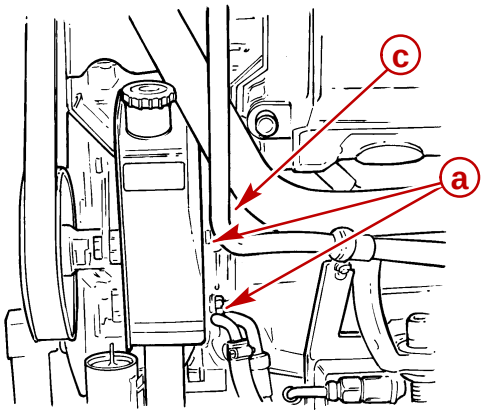
c. Thread the nut onto the pump shaft. Thread the pump shaft (and the nut) all the way onto the stud.

d. Ensure that the power steering pump pulley is flush with the pump flange.

## Installation

**IMPORTANT: Be careful to not cross-thread or overtighten the hose fittings.**

1. Place the power steering pump on the bracket and install the bolts and nuts. Torque the pump mounting bracket.

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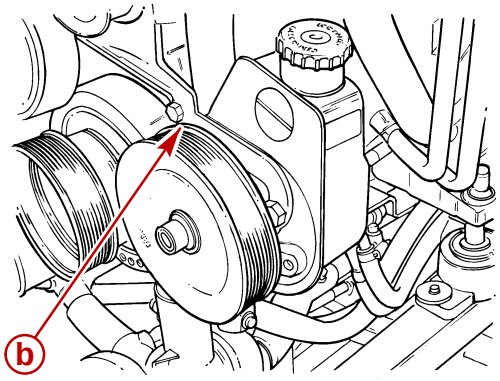


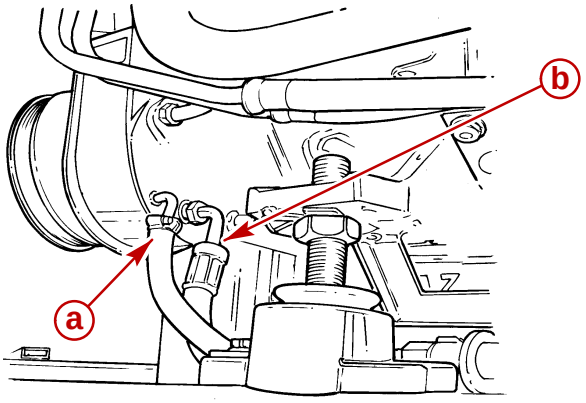

77830

**a** – Nuts
**b** – Bolts
**c** – Spacer

| Description | Nm | lb-in. | lb-ft |
|---|---|---|---|
| Pump Mounting Bracket | 41 | | 30 |

2. Using a new high pressure hose O-ring, install the threaded fitting in the back of the pump assembly. Tighten the fitting securely.

3. Connect the low pressure hose on the back of the pump. Tighten the hose clamp securely. Do NOT cross-thread or overtighten.




77827

**a** – Low Pressure Hose
**b** – High Pressure Hose

4. Install the mounting hardware and the fasteners to retain the pump to the bracket.

# Replacing Belt And/Or Adjusting Tension

Refer to SECTION 1B.

# Filling And Bleeding

Refer to SECTION 1B.

# Checking Fluid Level

Refer to SECTION 1B.

# Hydraulic Hoses And Fluid Cooler

The following information is provided to assist in the replacement of the power steering fluid hoses and to assure proper routing and connection to the cooler.

**IMPORTANT: Make hydraulic connections as quickly as possible to prevent fluid leaking.**

**IMPORTANT: Be careful to not cross-thread or overtighten the hose fittings.**

## High Pressure Hose (Pump-To-Control Valve)

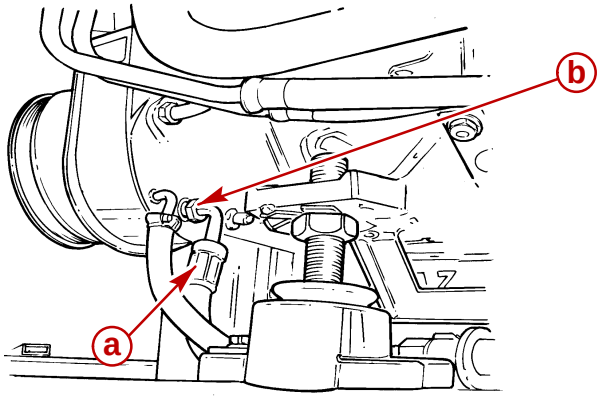
### REMOVAL

**⚠ CAUTION**

**ENVIRONMENTAL HAZARD! Discharge of oil or oil waste into the environment is restricted by law. Do not spill oil or oil waste into the environment when using or servicing your boat. Contain and dispose of oil or oil waste as defined by local authorities.**

***NOTE:*** *Catch the fluid that drains from the pump and the hoses in a suitable container.*

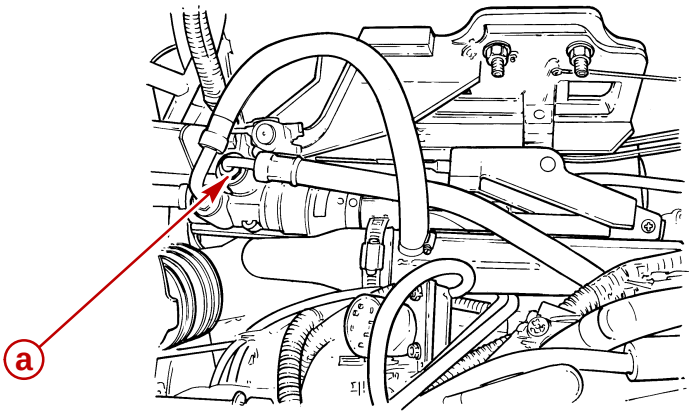
1. Remove the high pressure hose fitting with the O-ring seal from the pump fitting on the rear of the pump.




77827

**a –** High Pressure Hose Fitting (O-ring Not Shown)
**b –** Pump Fitting

2. Remove the hose where routed and secured (port or starboard side), across the top of the engine, near the valve cover.
3. Remove the fitting from the control valve at the transom. Remove the hose.




77845

**a** – Power Steering Hose Fitting

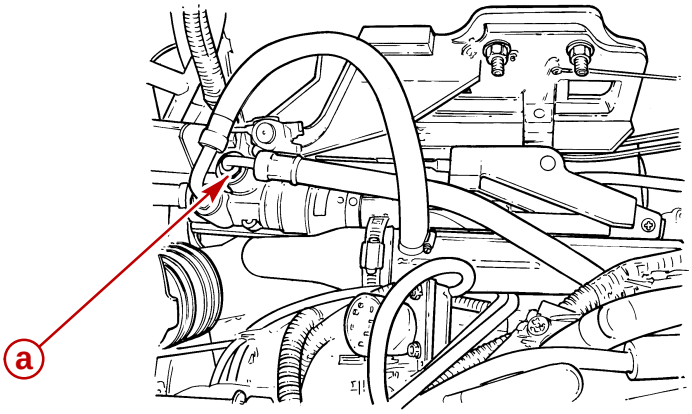
## INSTALLATION

**⚠ CAUTION**

**Route the hoses exactly as shown below. This will help avoid stress on the hose fittings and will help avoid kinks in the hoses.**

**IMPORTANT: Be careful to not cross-thread or overtighten the hose fittings.**

1. Route the hose in the same position as prior to removal. Install the power steering hose fitting and torque. Do NOT cross-thread or overtighten.

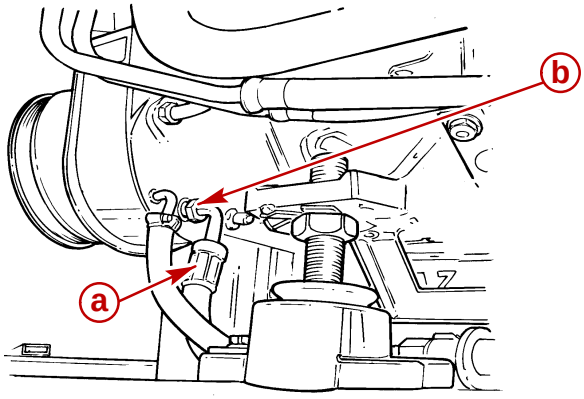



77845

**a** – Power Steering Hose Fitting

| Description | Nm | lb-in. | lb-ft |
|---|---|---|---|
| Power Steering Hose Fitting | 31 | | 23 |

2. Using a new high pressure hose O-ring, install the threaded fitting in the back of the pump assembly fitting. Tighten the fitting securely. Do NOT cross-thread or overtighten.




77827

**a** – High Pressure Hose Fitting (O-ring Not Shown)
**b** – Pump Fitting

3. Fill and air bleed the system. Refer to SECTION 1B.

## Low Pressure Hose (Pump-To-Fluid Cooler)

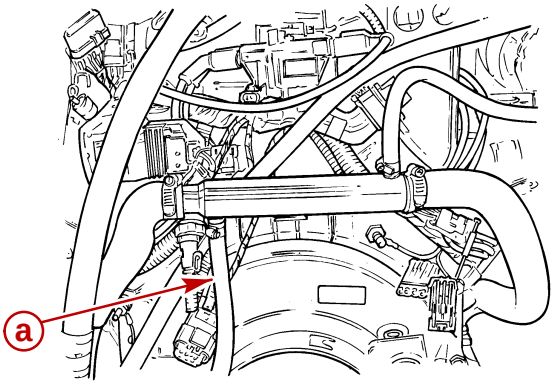
### REMOVAL

**⚠ CAUTION**

**ENVIRONMENTAL HAZARD! Discharge of oil or oil waste into the environment is restricted by law. Do not spill oil or oil waste into the environment when using or servicing your boat. Contain and dispose of oil or oil waste as defined by local authorities.**

***NOTE:*** *Catch the fluid that drains from the hose, the cooler and the pump in a suitable container.*

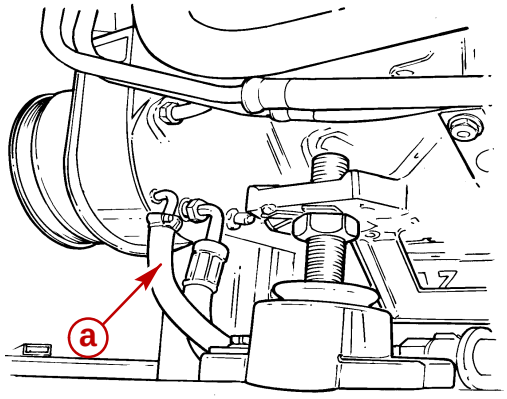
1. Loosen the hose clamp and remove the hose from the fluid cooler.




77826

**a** – Hose

2. Loosen the hose clamp and remove the hose from the back of the pump.

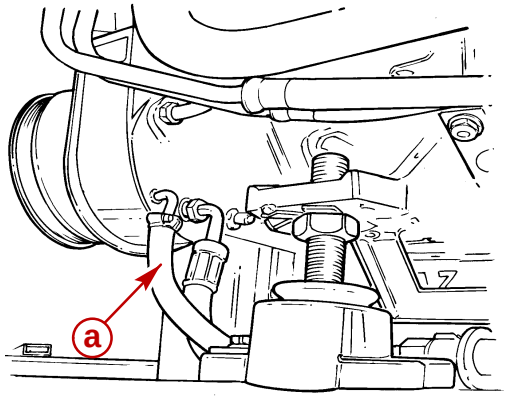



77827

**a** – Hose

## INSTALLATION

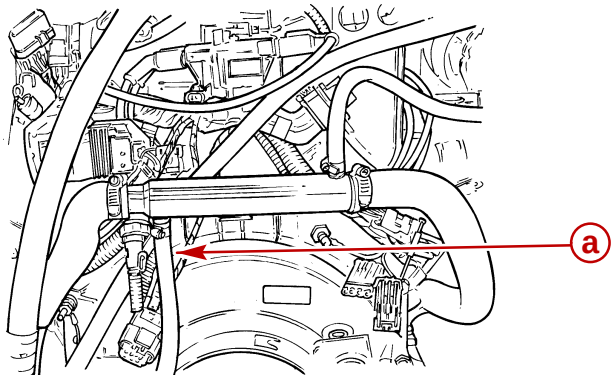
1. Using the hose clamp, install the new hose on the back of the pump. Tighten the clamp securely.




77827

**a** – Hose

2. Using the hose clamp, install the hose on the fluid cooler. Tighten the clamp securely.




77826

**a** – Hose

3. Fill and air bleed the system. Refer to SECTION 1B.

# Low Pressure Hose (Control Valve-To-Fluid Cooler)

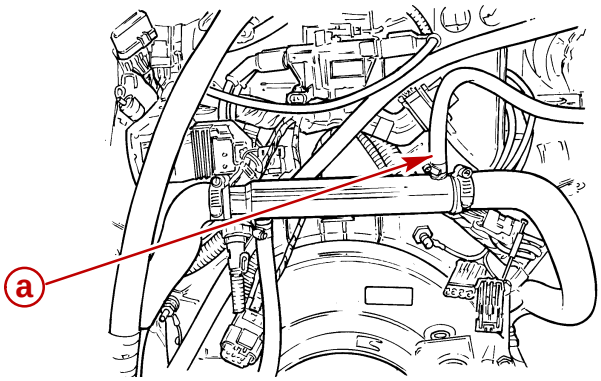
## REMOVAL

**⚠ CAUTION**

**ENVIRONMENTAL HAZARD! Discharge of oil or oil waste into the environment is restricted by law. Do not spill oil or oil waste into the environment when using or servicing your boat. Contain and dispose of oil or oil waste as defined by local authorities.**

***NOTE:*** *Catch the fluid that drains from the hose, the cooler and the pump in a suitable container.*

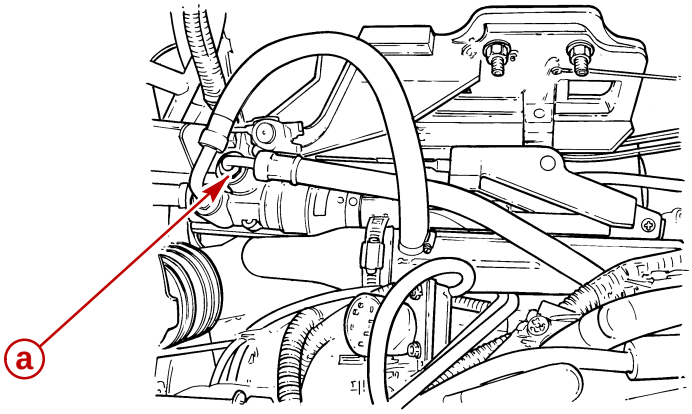
1. Loosen the hose clamp and remove the hose from the fluid cooler.




77826

**a –** Hose

2. Remove the fitting from the control valve at the transom. Remove the hose.




77845

**a –** Power Steering Hose Fitting

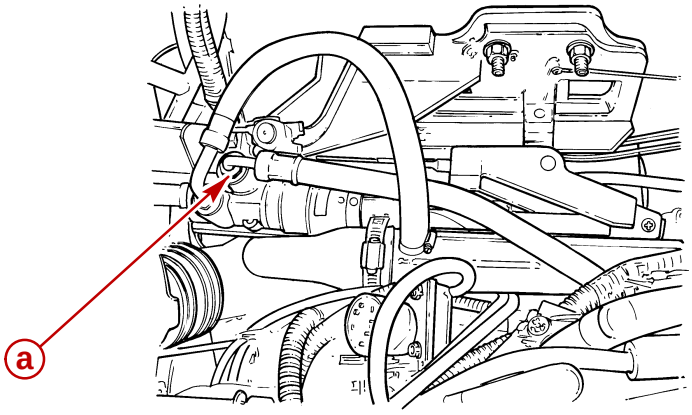
## INSTALLATION

**⚠ CAUTION**

**Route the hoses exactly as shown below. This will help avoid stress on the hose fittings and will help avoid kinks in the hoses.**

**IMPORTANT: Be careful to not cross-thread or overtighten the hose fittings.**

1. Position the hose properly (as prior to removal). Install the fitting and torque. Do NOT cross-thread or overtighten.

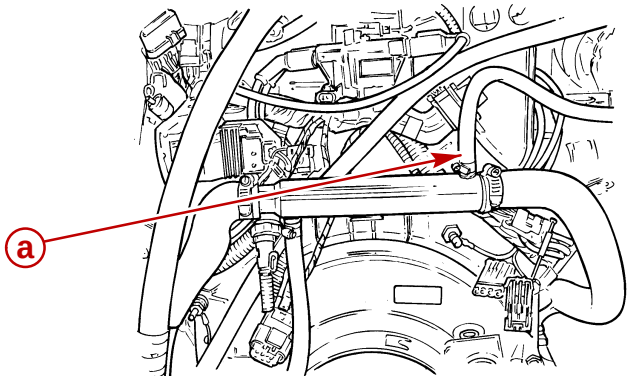



77845

**a –** Power Steering Hose Fitting

| Description | Nm | lb-in. | lb-ft |
|---|---|---|---|
| Power Steering Hose Fitting | 31 | | 23 |

2. Route the hose along the flywheel housing and secure with the J-clamps provided.
3. Using the hose clamp, install the hose on the fluid cooler. Tighten the clamp securely.




77826

**a –** Hose

4. Fill and air bleed the system. Refer to SECTION 1B.

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